JULY, 1950

PETROLEUM REFINER

SPECIALIZED FOR REFINING, NATURAL GASOLINE AND PETROCHEMICAL ENGINEERING, OPERATION AND MANAGEMENT

THESE are Hortonspheroids. Their distinctive contour signifies economy as well as graceful appearance when you are storing volatile hydrocarbons. The spheroidal form is economical because it uses steel to the best advantage in resisting the internal pressures that are needed to prevent excessive evaporation loss during storage and handling of such hydrocarbons.

Hortonspheroids reduce evaporation loss, cut down corrosion and decrease the fire hazard for volatile liquids requiring storage pressures from 2½ to 100 lbs. per sq. in. This includes refinery charging stocks, butanes, some grades of motor fuel, and all natural gasolines. For assistance in selecting the right pressure for your requirements, write the nearest office of the . . .

CHICAGO BRIDGE & IRON COMPANY

Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PENNSYLVANIA

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Beckman pioneers another instrumentation advancement . . .

SINGLE BEAM *direct* Transmittancy *recording* *with* BECKMAN *infrared spectrophotometers*

NEW SINGLE BEAM SYSTEM IS SIMPLE, ACCURATE, RELIABLE

The Beckman Single Beam Direct Transmittancy Recorder employs the memory standardization principle, using reliable electronic circuits instead of complicated mechanical-optical arrangements. It successfully combines the highest accuracy with the utmost in reliability and convenience. A standardizing run is made on the empty or solvent-filled absorption cell. During this run the signal from the photoreceiver is automatically maintained constant, and the resulting slit width vs. wavelength function is "memorized" on a wire recorder. The sample is then placed in the same cell, and information played back from the wire recorder automatically controls the wavelength and slit drive motors to reproduce precisely the conditions which produced the constant 100% reference level. Any absorption resulting from the sample is accurately and automatically recorded directly in transmittancy. On repeat runs, the same reference wire is used, eliminating repetition of standardizing measurements.

Single beam transmittancy recording retains the excellent resolution, low stray light, high stability and drift freedom, and the wavelength accuracy of the well-known Beckman Spectrophotometers. Other advantages are summarized at the right.

THREE UNEXCELLED INSTRUMENTS FOR ANY REQUIREMENT

Beckman Single Beam Direct Transmittancy Recording is available either (1) as an accessory unit for direct installation on any Beckman IR-2 Spectrophotometer, or (2) with the IR-2 as a complete instrument, or (3) in the new unsurpassed Beckman IR-3 Spectrophotometer – the most versatile, most accurate, most complete – and by all standards, the *finest* spectrophotometer money can buy.* For further information on these instruments write . . .

Beckman Instruments, Inc., South Pasadena 25 California.

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control modern industries

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**As in all Beckman instruments, your money buys more value than in any similar product.*

IMPORTANT ADVANTAGES of the Beckman Transmittancy Recorder

- **GREATER CONVENIENCE:** The single-beam principle eliminates troublesome, time-wasting cell- and beam-matching problems.
- **GREATER VERSATILITY:** Greater versatility and simplicity and lower costs are assured, since special cells and attachments need not be duplicated for use in a reference beam.
- **GREATER ACCURACY:** The single-beam principle eliminates problems of making a beam attenuator achromatic, linear and free of vignetting effects.
- **MINIMUM STRAY LIGHT:** Only these single beam instruments use a filter-type beam chopper, reducing stray light effects to a minimum (less than 2% at 15 microns with the IR-2).
- **MINIMUM SCANNING TIME:** Optimum recording efficiency is achieved because each spectral slit width is traversed in a time proportional to the response period of the recording system. Any other scanning rate loses either resolution, time or accuracy.
- **MAXIMUM RESOLUTION:** Slit width control has the advantage that the instrument is always working at maximum resolution for the chosen amplification and scanning speed.
- **FLEXIBILITY OF CONTROL:** Operating speed, resolution and chart scales can be easily varied over wide ranges. A single control adjusts scanning time per spectral slit width from 1 second to 128 seconds by factors of 2. The wavelength motor speed is electronically controlled with no gear shifting needed to change scanning speed.

In addition to recording linearly in wavelength, a unique electronic system enables recordings to be made linearly in other functions such as frequency or log wavelength.

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PETROLEUM REFINER

Specialized for Refining, Natural Gasoline and Petrochemical Engineering, Operation and Management

R. L. DUDLEY, *President* A. L. BURNS, *General Manager*

VOLUME 29, No. 7 JULY, 1950

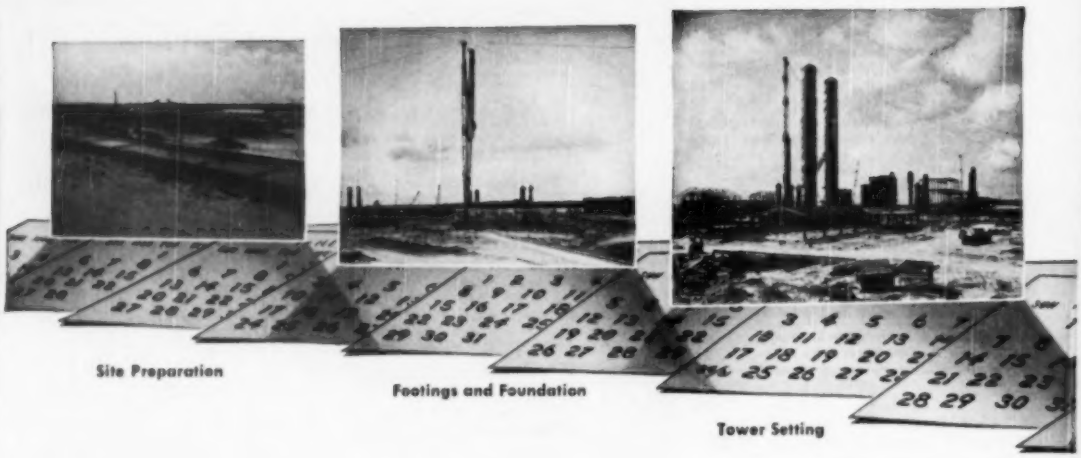
Contents

- **Gains in Last Half of 1950 Foreseen by Jersey Standard Head** 63
- **Tidelands Decision Imperils States Rights** 64
- **Residual-Oil Hydrogenation** 83
  The hydrogenation process appears economical for the conversion of heavy residual oils to distillate fuels in some areas. Fifty octane number diesel fuel and motor gasoline are the main products.
  L. C. Skinner, E. E. Dennis, H. Schuppert, and B. Prem
- **Engineers of Three Nations Construct Big Cat Cracker** 88
  Erection details show the field assembly of the regenerator of a fluid catalytic cracking unit.
- **Operating Alternatives on Basis of Cost Analysis** 90
  A tool for the investigation of relative refinery costs under changing the flexible budget principle—is applied to several sets of typical refinery operating circumstances.
  John L. Fox
- **Corrosion Resistant Liners in Refinery Vessels** 93
  The internal protection of refinery process vessels becomes increasingly important as throughs are increased and crudes become progressively less sweet and more salty.
  G. C. Carpenter
- **Petrochemicals Play Big Part in U.K. Industrial Progress** 104
  Fluid catalytic cracking unit forms the basis for a variety of petrochemicals manufacturing operations.
  V. S. Swaminathan
- **Liquid-Phase Hydrogen Sulfide Removal** 107
  The tripotassium phosphate process is judged the optimum route for the treatment of catalytic polymerization unit charge stock at the Tulsa refinery of Mid-Continent Petroleum Corporation.
  L. W. Schumacher
- **Compression Ratio, Octane Demand, and Lubrication** 111
  Engine designers and builders can do much to lessen the problems of the refining industry and to aid in the conservation of our reserves of crude oil.
  E. J. S. Pigott
- **Inventions and Patents, Part II** 115
  Procedures to be followed in securing patents and the functioning of the Patent Office.
  Arthur H. Seidel and E. D. Bonner
- **Process Gives Plant Water Free of Scale and Corrosion** 119
  Adequate water conditioning has allowed plant operation over extended periods without cleaning or replacement of tubes in condensers and coolers.
  John C. Albright
- **Road Testing Evaluates Gasoline Performance** 123
  Laboratories on wheels serve to determine octane ratings under road conditions and to demonstrate ways of rating gasolines.
- **High Pressure Hydrogenation of Carbonaceous Matter, Part VII, The Vapor Phase, Section B** 124
  Properties of liquid products and comparison of process method with other possible routes.
  Peter W. Sherwood
- **Thermochemistry for the Petrochemical Industry, Part XII, Oxides of Nitrogen** 129
  Enthalpies and heat capacities for nitrogen, nitrous oxide, nitric oxide, and nitrogen dioxide.
  Kenneth A. Kobe and Robert E. Pennington
- **GE Products and Ideas form Cargo on "More Power to America" Train** 134
  Industrial exhibits include power generation, transmission, and distribution; drives and controls; materials handling; welding; industrial heating; renewal parts; industrial lighting, components for industry; measurements; civic improvement; and national security.
- **Expansion Joints—Their Maximum Spacing** 135
  Expansion joints that are selected and spaced so that their rated travel is not exceeded in operation may still fail through collapse due to an "Euler Column" instability. A discussion of a not-too-well known design problem.
  Robert G. Blick

DEPARTMENTS

The Look Box 59
Refinery and Other Plant Construction 69
Refiner Authors and Other Personalities 138
How to Do It 142
The Month in the Industry 147
The Oil Man's Calendar 150
Science and Technology Abstracts 157
Compiled by Dr. E. H. Leslie and Dr. H. B. Coats
Digest of United States Patents Pertaining to Petroleum 165
Compiled by Heinz Heinemann
Book Reviews 181
New Equipment, Manufacturers' Literature 185
About Equipment and Service Supplies 214
Index to Advertisers 226

your project "Scheduled by



Site Preparation

Footings and Foundation

Tower Setting

Scheduled by Lummus means engineering and construction is a complete integration of planning, forecasting and cost control, applied with individual responsibility from start to finish. Lummus' complete scheduling of your refinery project smooths the work flow. There is no wasted effort. You can count on delivery of an economical, well functioning plant on or before the required completion date.

Scheduled by Lummus means plant engineering starts earlier than conventional work planning. It begins with original process design and job engineering. Because time is money, the project is engineered from the start with emphasis on time-economies in the entire erection operation. Erection methods are analyzed in advance from the standpoint of practical application at the site.

THE LUMMUS COMPANY
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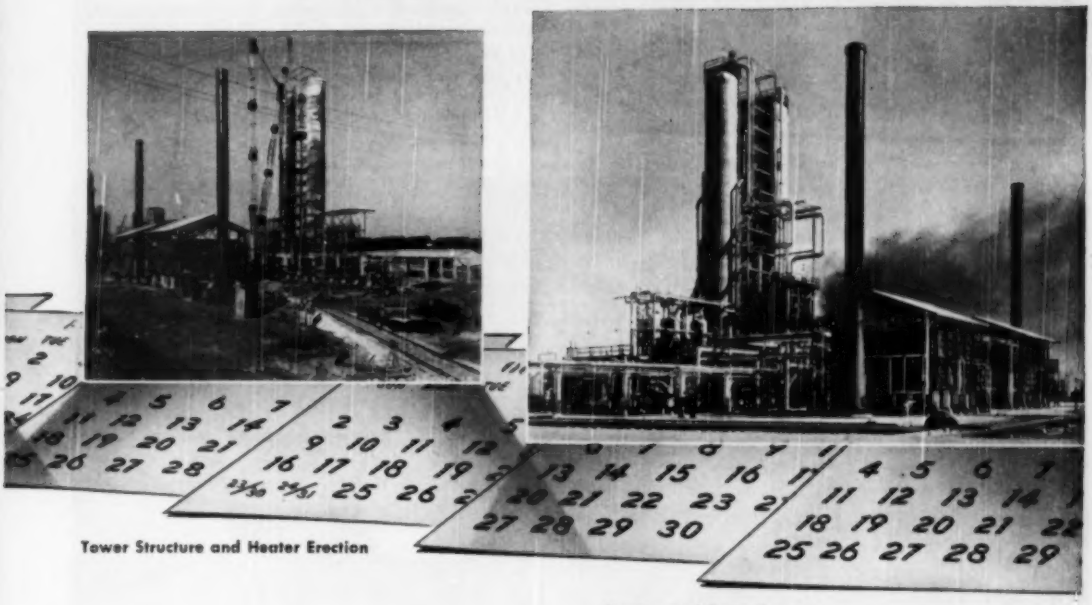
Lummus

means READY ON TIME



Tower Structure and Heater Erection

Start-up and Operation

Scheduled by Lummus means all materials are planned to arrive as needed. Just the construction tools and skills required for the immediate use of these materials are provided at each successive stage of the job. Costs are kept under day-to-day scrutiny and control. Problems of delivering, erecting and coordinating individual units into an operating whole are anticipated, with hundreds of previous records as a guide.

Lummus' wide range of experience is the key to this thorough and advanced method of procedure. One recent job went from letting of contracts to successful operation in eight months. Another complete foreign refinery was completed in fifteen months. Your next project, "scheduled by Lummus" can be the answer to realistic cost control and the economies that come with completion on or ahead of schedule. ●

PETROLEUM HORIZONS, the new 80-page book on Lummus processes and plants, features a step-by-step description and flow sheets for 31 refinery processes. It brings you complete details on the background, organization and world-wide services of the Lummus Company. Your copy available on request.

Want the best life/cost ratio from your tubes? Ask the experts!

This month Timken reports on: **SICROMO 2**

Has outstanding surface and structural stability at 1200°F. Has better oxidation and corrosion resistance than 2¼ Cr.-Mo. steel. Recommended for service up to 1200°F. as tubes in cracking coils, reforming units, heat exchangers, vapor line and hot oil piping. Also as return bend forgings for oil heaters.

ONE OF 23 TIMKEN HIGH TEMPERATURE STEELS

Carbon	Sicromo 2	Sicromo 5S	16-13-3*
Carbon-Mo.	Sicromo 2½	Sicromo 5MS	25-20*
DM-2	2¼% Cr.-1% Mo.	Sicromo 7	25-12*
Silmo	Sicromo 3	Sicromo 9M	35-15*
DM	4-6% Cr.-Mo.	18-8 Stainless	16-25-6*
2% Cr.-Mo.	4-6% Cr.-Mo.-Ti.	18-8 Cb	

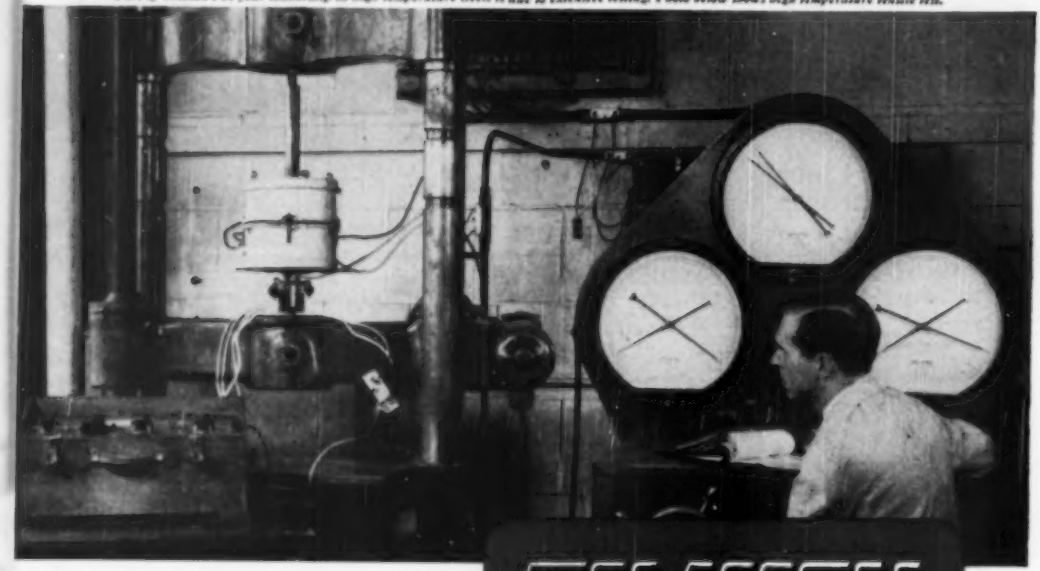
**Available as seamless tubing on an experimental basis only.*

THERE'S only *one* way to get maximum life per dollar invested from high temperature tubes. That's by selecting the *right* steel to fit your particular operating conditions.

And there's *one* group of acknowledged experts best fitted to help you—the high temperature metallurgists of The Timken Roller Bearing Company. They are backed by more than 20 years of leading reasearch—by the widest field experience in high temperature problems. They have 23 analyses—many Timken-developed—to choose from. They supply *assured* quality tubes—made under Timken's complete, rigid control, from melting through final inspection.

Let Timken's "RSQ"—Research, Supply, Quality—solve *your* tube problems. Ask the experts! The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

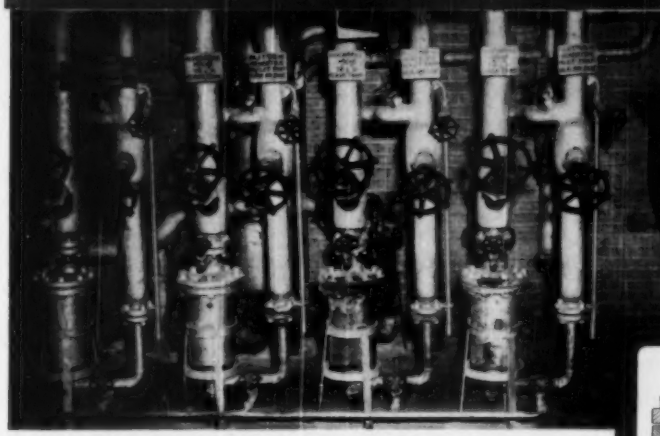
Part of Timken's 21-year leadership in high temperature steels is due to extensive testing. Photo below shows high temperature tensile test.



YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

Specialists in alloy steel—including hot rolled and cold finished alloy steel bars—a complete range of stainless, graphitic and standard low analyses—and alloy and stainless seamless steel tubing.

steam traps



List of Materials

CAP and BODY FORGINGS:*
Up to 600 psig—S.A.E. 1030 steel
600 to 900 psig—ASTM F-1 moly-steel
900 to 1500 psig—ASTM F-7 chrome moly-steel

VALVE AND SEAT:
Chrome steel, heat treated

BUCKET and VALVE LEVER ASSEMBLY:
18-8 Stainless Steel

BOLT and NUT SET:*
Bolts Class C, 125,000 lbs. tensile
Nuts, hex, semi-finish, S.A.E. 1030

GASKET:*
Compressed graphited asbestos

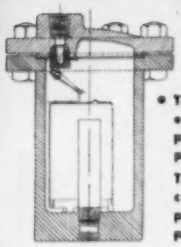
*Does not apply to No. 3211 nor No. 913

1. FOR HIGH PRESSURE SERVICE — engineers responsible for the design or operation of high pressure, high temperature steam plants can specify with confidence Armstrong Forged Steel Steam Traps to provide completely automatic condensate drainage throughout. These traps are "standard" in leading power stations throughout the entire world where they are used for draining headers, desuperheaters, soot blowers and other drip points at pressures as high as 2400 psig! These traps always open when filled with condensate and there is no steam loss under no-load conditions. Safety and dependability are assured through use of modern materials, highest quality workmanship and critical inspection.

2. FOR ALL-STEEL INSTALLATIONS — Armstrong Forged Steel Traps also ideally meet the increasing demand in power plants, refineries and general industry for all-steel fittings on lower pressures (up to 250 psig) because they are light in weight and surprisingly low in price. They provide the maximum in safety, dependability, shock and fire resistance.

● FOR COMPLETE DATA ask for the 36-PAGE ARMSTRONG STEAM TRAP BOOK or see our catalog in Sweet's.

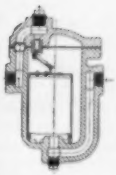
ARMSTRONG MACHINE WORKS
852 Maple Street, Three Rivers, Michigan



● **Traps with screwed connections for pressures to 900 psig.**

Traps with flanged connections for pressures to 2400 psig.

● **No. 3211 trap for pressures to 250 psig, only $14.00.**



● **Side inlet cast steel trap for pressures to 600 psig, screwed or flanged connections.**

ARMSTRONG STEAM TRAPS

Why should you specify Wolverine Condenser Tubes?

Let's continue our summary:

3rd Because no copper or copper alloy tube can be produced any better than Wolverine condenser tube it should be given serious consideration. It is a top quality tube. From ore to finished product—during the progressive steps of manufacture—it is constantly under careful inspection; so when your supply of Wolverine tube reaches you, you can feel confident that its installation will give you the kind of performance you expect—DEPENDABLE.

4th Wolverine tube is produced by a company with a background of over thirty years of tube making exclusively. The company has been concentrating all its skill, research and engineering efforts in the tube field alone. You can, therefore, picture the wealth of experience represented here and how much you can gain by drawing on it for any help you may require.

Consult us at any time. When you consider tubing, think of Wolverine.

Send for Our Condenser Tube Brochure

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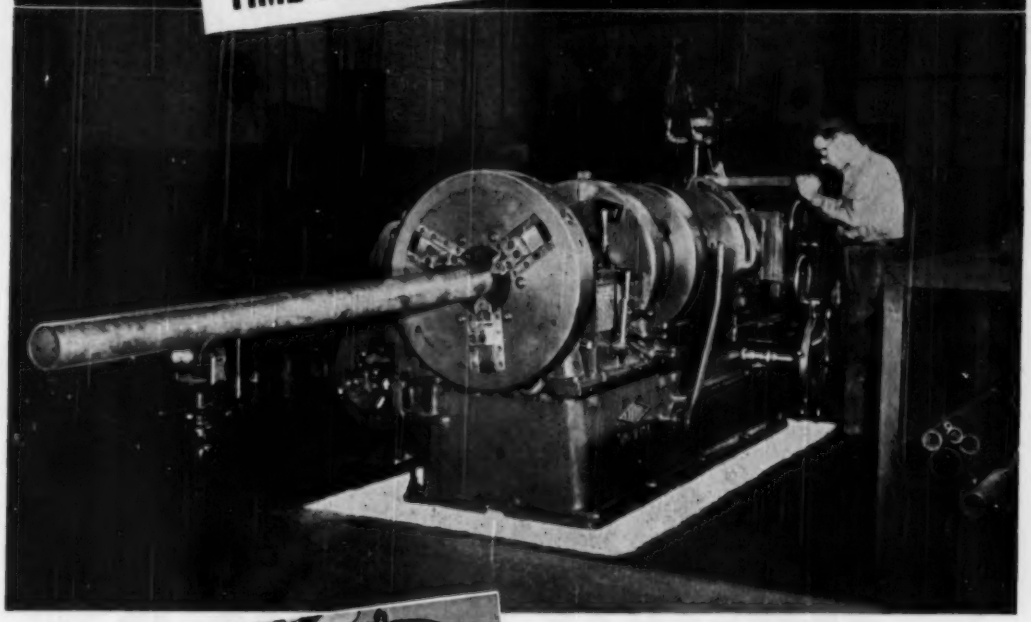
PLANTS IN DETROIT AND DECATUR, ALA.
Sales Offices in Principal Cities

VERSATILITY

Saves TIME & MONEY in Maintenance Shops



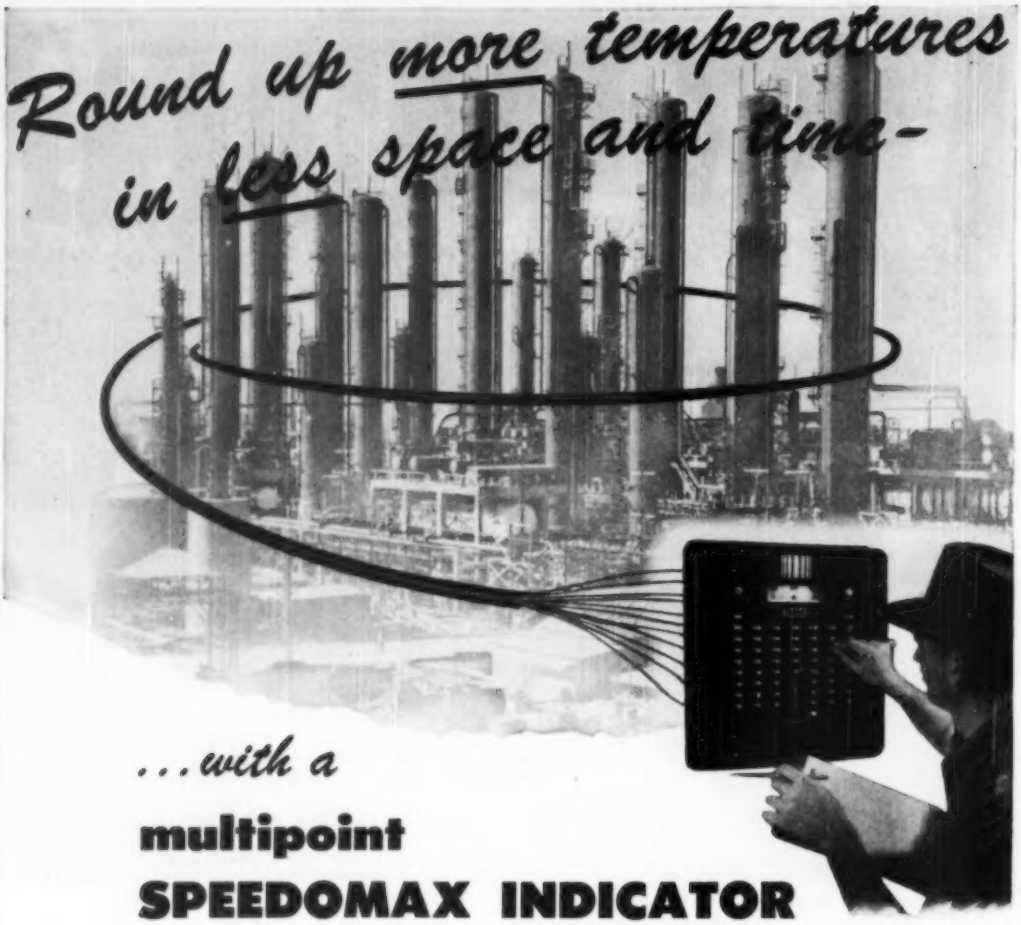
Photographs show a Landis Pipe Threading Machine installation in a Job Shop of the New York Central Railroad. This shop, located at Weehawken, New Jersey, operates as a Marine Repair Shop handling maintenance for tugs, barges, lighters, etc. Illustrations show wrought iron pipe being cut off after reaming and threading. Standard pipe threads are cut 1½" long on the 4" pipe, using a cutting speed of 25 surface feet per minute. This machine is also used for cutting boiler tubes to length.

The wide diametrical range of the die heads and the use of patented tangential pipe chasers gives these machines a versatility invaluable in maintenance work. For example, the 6" Landis Pipe Threading Machine illustrated threads all pipe sizes from 1" to 6", inclusive. Size adjustment of the die head is simple and quick. Chasers need not be changed except for threads of a different pitch, form, or taper. Chasers are interchangeable and need only be replaced singly as needed. Tangential cutting action reduces wear, and chasers can be reground to use over 80% of their length. Write for Bulletin C-61.

LANDIS *Machine* COMPANY

WAYNESBORO PENNSYLVANIA U. S. A.

Round up more temperatures in less space and time-



. . . with a

multipoint SPEEDOMAX INDICATOR

MORE than twice as many unit temperatures can be checked with a *single* Speedomax Indicator as with any other one, self-contained standard instrument available today. Reason is unique design which lets one instrument case hold both Indicator and all connections from as many as 126 thermocouples. Thus, an operator can check all unit temperatures without reaching for out-of-the-way switch boxes . . . without moving a foot. Such convenience is ideal for routine logging. And in emergency, when many more couples must be checked with least delay, this type of Speedomax can become vital.

Speedomax is fast as well as convenient. Its drum-mounted scale spins from lowest to highest temperature in 4 seconds; for smaller jumps, proportionately faster. This standard speed can be cut to 2 seconds if desired.

Key type switches—relied upon for years in refineries—are employed for their dependable service. Push-button or rotary switches can also be supplied, but accommodate fewer thermocouples per instrument.

Some refineries also use another Speedomax model which not only indicates, but can be switched to automatic signalling or recording. It fans through 20 to 160 thermocouples at only 4 seconds apiece.

If you have an application in mind, an L&N field engineer will call, or send catalog, as you prefer. Just write Leeds & Northrup Co., 4923 Stenton Ave., Phila. 44, Pa.

Int. Ad ND46-33A-700(1)

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT TREATING FURNACES

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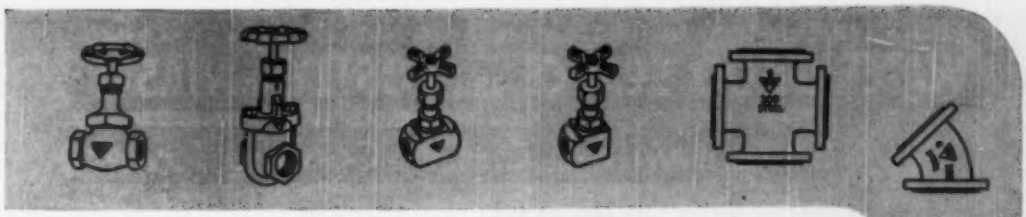
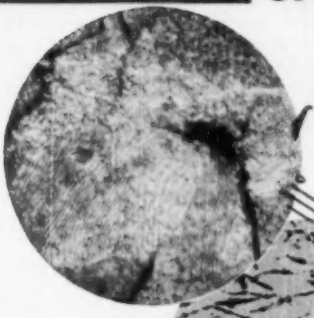


THE MICROSCOPE SHOWS WHY

R·P&C Electric Iron Valves

GIVE SUPERIOR SERVICE



PEARLITIC MATRIX
MAGNIFIED 500X—shows the sound banded structure of the base from which the desirable physical characteristics come.

GRAPHITE FLAKES
MAGNIFIED 100X—fineness of graphite flakes minimizes possibility of weak spots—results in stronger iron.

CLOSE ANALYSIS CONTROL
—possible in the electric furnace—results in a pearlitic matrix, evenly distributed graphite, minimum sulphur and phosphorus, superior iron, sound castings, high quality valves. All R-P&C IRON VALVES are made of Electric Cast Iron.

Ask your R-P&C Distributor for copies of these Bulletins DH-8 and DH-136 which describe in more detail the R-P&C line of Iron Valves

ACCO Reading, Pa., Atlanta, Baltimore, Boston, Chicago, Denver, Detroit, Houston, New York, Philadelphia, Pittsburgh, San Francisco, Bridgeport, Conn.

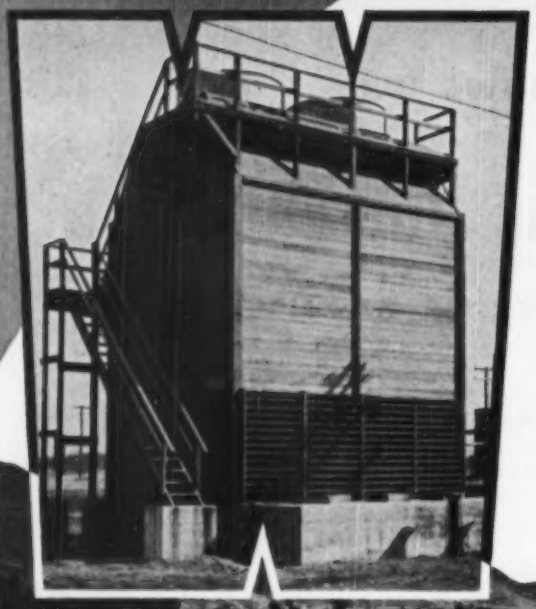
R-P & C VALVE DIVISION
AMERICAN CHAIN & CABLE

TRADE MARK

READING-PRATT & CADY VALVES

WATER'S TOO SCARCE and COSTLY to WASTE

Save it with a C. H. W. Cooling Tower



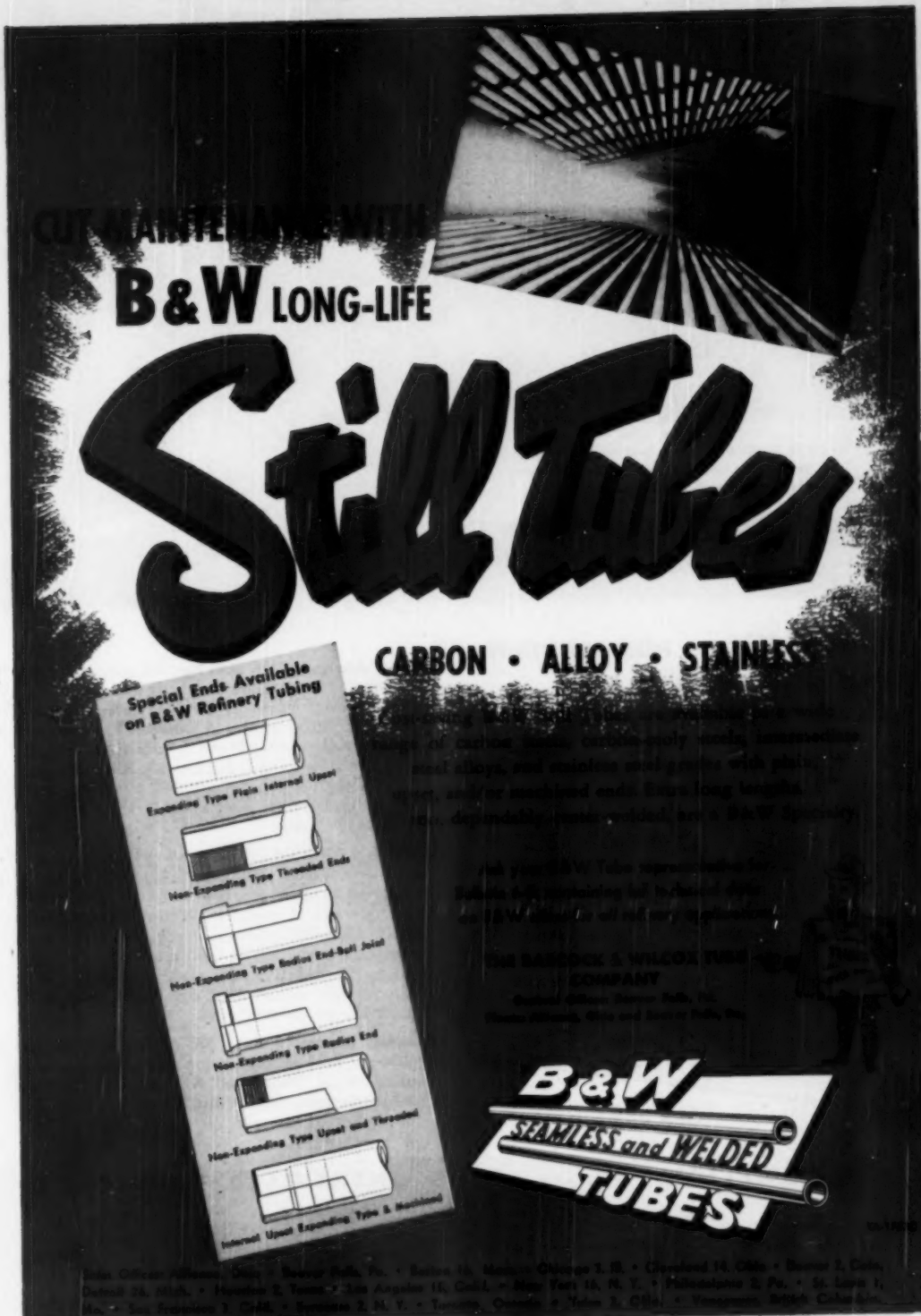
Look how much this source of water has dried up! And this is no exception, either. More and more plants are feeling the "pinch" in water supply. Industrial expansion, plus higher domestic use, has overtaxed supply in many areas. Good surface water sources are low and, in areas where there is plenty, the quality is poor and costly to make usable. Although sufficient underground water deposits exist,* it will be several years before they can be tapped. All this means that you'll have to get the most out of what you have, or face production cuts or even a shutdown. But there is something you can do—use a C. H. W. cooling tower for operations requiring cooled water, thus permitting use of the same water over and over again. And you'll find that a C. H. W. cooling tower will not only save water and its cost, but also that cooling performance is guaranteed. For any operation requiring cooled water—chemical, processing, petroleum, air conditioning, etc.—check on a C. H. W. cooling tower first. Write for literature.

*According to Government surveys

C. H. WHEELER MANUFACTURING CO.
1818 Sedgley Ave., Philadelphia 32, Pa.
REPRESENTATIVES IN MOST PRINCIPAL CITIES

C. H. Wheeler
SINCE 1903

DECK MACHINERY · STEAM CONDENSERS
STEAM JET AIR EJECTORS
OF PHILADELPHIA


B&W LONG-LIFE
Still Tubes
CARBON • ALLOY • STAINLESS
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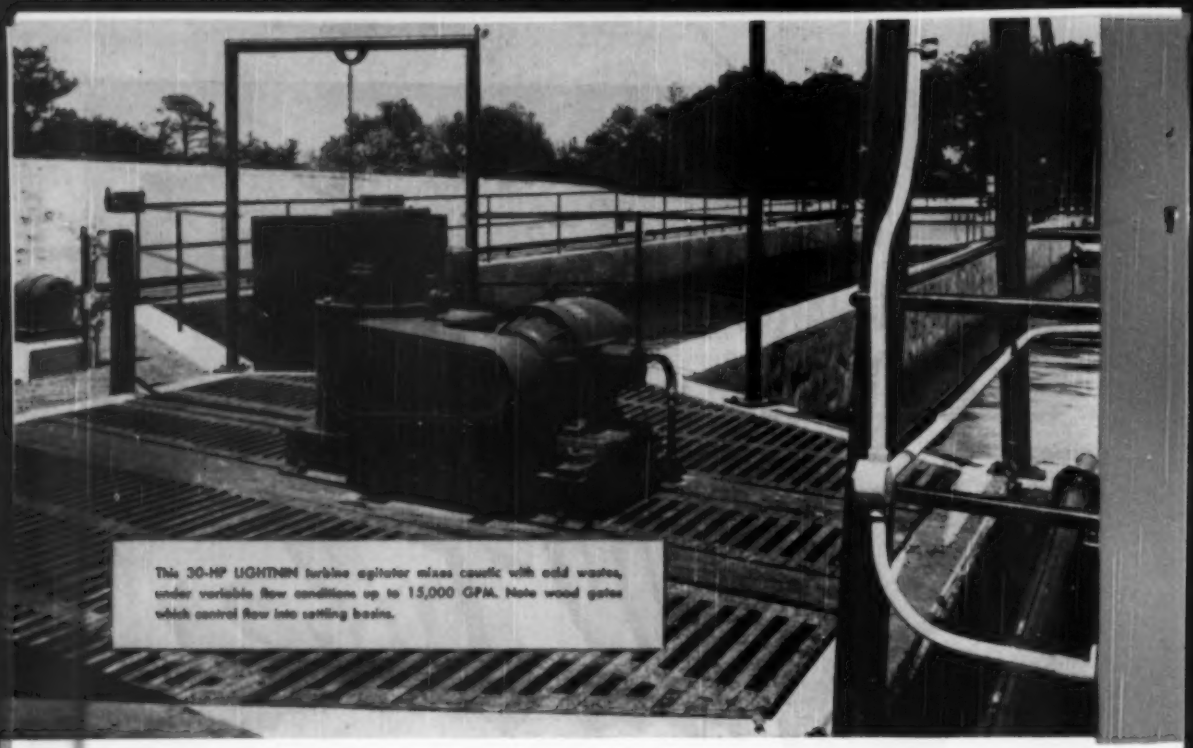
Expanding Type Plain Internal Upset
Non-Expanding Type Threaded Ends
Non-Expanding Type Radius End-Butt Joint
Non-Expanding Type Radius End
Non-Expanding Type Upset and Threaded
Internal Upset Expanding Type & Machined
B&W
SEAMLESS and WELDED
TUBES



This 30-HP LIGHTNIN turbine agitator mixes caustic with acid wastes, under variable flow conditions up to 15,000 GPM. Note wood gates which control flow into settling basins.

Lightnin Mixers HELP MAINTAIN CLOSE pH CONTROL AT HIGH VARIABLE FLOW RATES

APPLICATION DATA:

OPERATION: Continuous rapid neutralization of acidic wastes with caustic solution.

COMPONENT	PCT. BY VOL.	pH RANGE	FLOW RATES
Acidic Wastes	96 – 100	1 – 6	5,000 – 15,000 GPM
20% Caustic	0 – 4		0 – 250 GPM*
Organic Solids	up to 1		

*Flow rate of Caustic regulated by automatic pH control equipment.

NEUTRALIZER PIT: Hexagonal, concrete, lined with corrosion-resistant material.

DIMENSIONS: 14'6" across flats, 13'6" deep.

CAPACITY: 16,250 gals. APPROX. LIQUID DEPTH: 11'.

BATCH: 13,000 gals. BATCH RATIO: 0.8

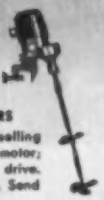
SETTLING BASINS: Concrete, 20' wide, 100' long; sloping bottom, 9'6" to 14' deep.

MIXCO Analysis: Flow rates specified gave a retention time of 0.87 to 2.6 minutes. To obtain a minimum of 2.1 turnovers with maximum flow, a turbine pumping capacity of 32,000 GPM was required. Turbine factor was calculated as 1.54, on basis of turbine location, acid sp. gr., viscosities, tank shape and baffling. Exclusive MIXCO agitation data showed that a stabilizing ring could be used, rather than a steady bearing, on the required 11'9" shaft.

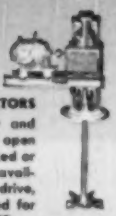
Solution: LIGHTNIN Model 5D-WQ-3000, 30-HP Agitator, with V-belt drive from 1750-RPM motor, to provide output shaft speed of 61 RPM. Belt permits 25% speed reduction if required. Agitator equipped with dual 48" multi-blade flat blade turbine impellers, spaced properly apart on shaft. Turbines selected for full motor loading. All immersed parts made of Hastelloy B, to resist corrosive action. Tank fitted with three baffles at midpoints of alternate sides.

Results: Extremely close pH control. All organic solids are held in suspension and carried over to settling basins. The LIGHTNIN Agitator has given trouble-free service since installation two years ago.

A COMPLETE LINE . . . PLUS UNEXCELLED TECHNOLOGY



LIGHTNIN PORTABLE MIXERS
World's largest-selling line. Electric or air motor; direct or gear drive. Sizes ⅛ to 3 HP. Send for Catalog B-75.



LIGHTNIN TOP ENTERING AGITATORS
Turbine, propeller and paddle types. For open or closed tanks. Fixed or variable speeds available in heavy duty drive, ¼ to 200 HP. Send for Catalogs B-89, B-78.

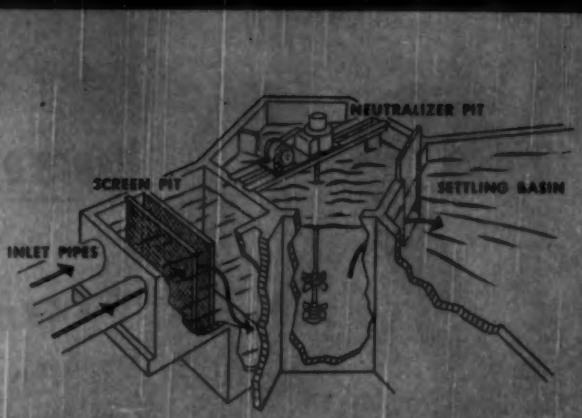
LIGHTNIN SIDE ENTERING MIXERS
For tanks up to 5 million gallons. Gear motor or V-belt drive; motorless types. Sizes 1 to 25 HP. Send for Catalog B-76.

NEUTRALIZING CHEMICAL WASTES

with

Lightnin® Mixers

(MIXCO® Engineered)



Caustic is added to acidic wastes in screen pit. Materials are then thoroughly mixed while flowing through neutralizer pit to settling basin.

This case story illustrates how MIXCO engineers take hold of *any* fluid agitation problem . . . and work it out to a happy solution.

MIXCO Technology lets you know *in advance* what the results will be. Equipment is sized from exclusive engineering data, based on MIXCO's 25 years as fluid agitation specialists. Every installation is performance-guaranteed.

LIGHTNIN Mixers are the world's most complete line of standard ready-to-use units. Lightnin gives you *unlimited range of variables, from standard components*. Widest choice of accessories, materials and modifications assures quick, accurate sizing of the agitator to your exact needs.

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For descriptive literature on LIGHTNIN Mixers, check and mail coupon today

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- ☐ B-78 Top Entering Mixers (Propeller Type)
- ☐ DH-50 Laboratory Mixers
- ☐ B-89 Top Entering Mixers (Turbine and Paddle Type)
- ☐ B-75 Portable Mixers (Electric and Air Driven)

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TELEPHONE MAIN 5111, BRANCH 234

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April 1st, 1950

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Denham Building,
Denver, Colorado.

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Yours very truly,

THE LEYDEN LIGNITE COMPANY,

BY [signature] Nash
President and General Manager.

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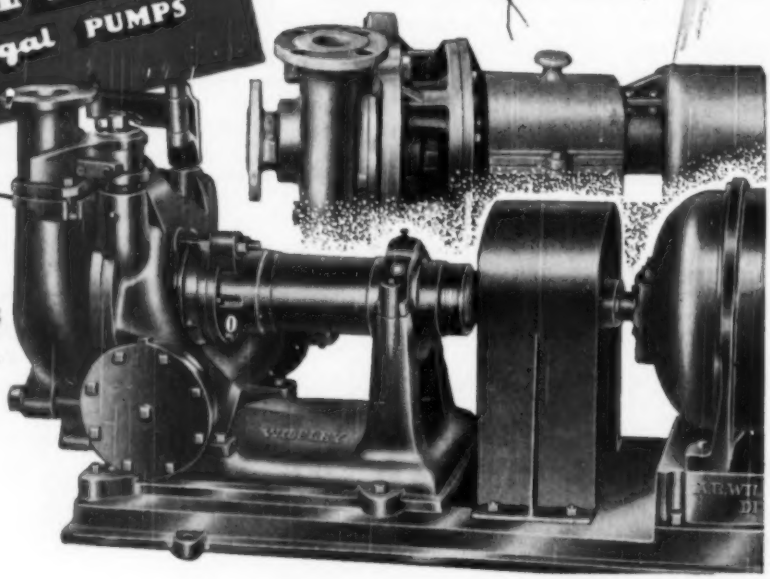
WILFLEY *centrifugal* PUMPS



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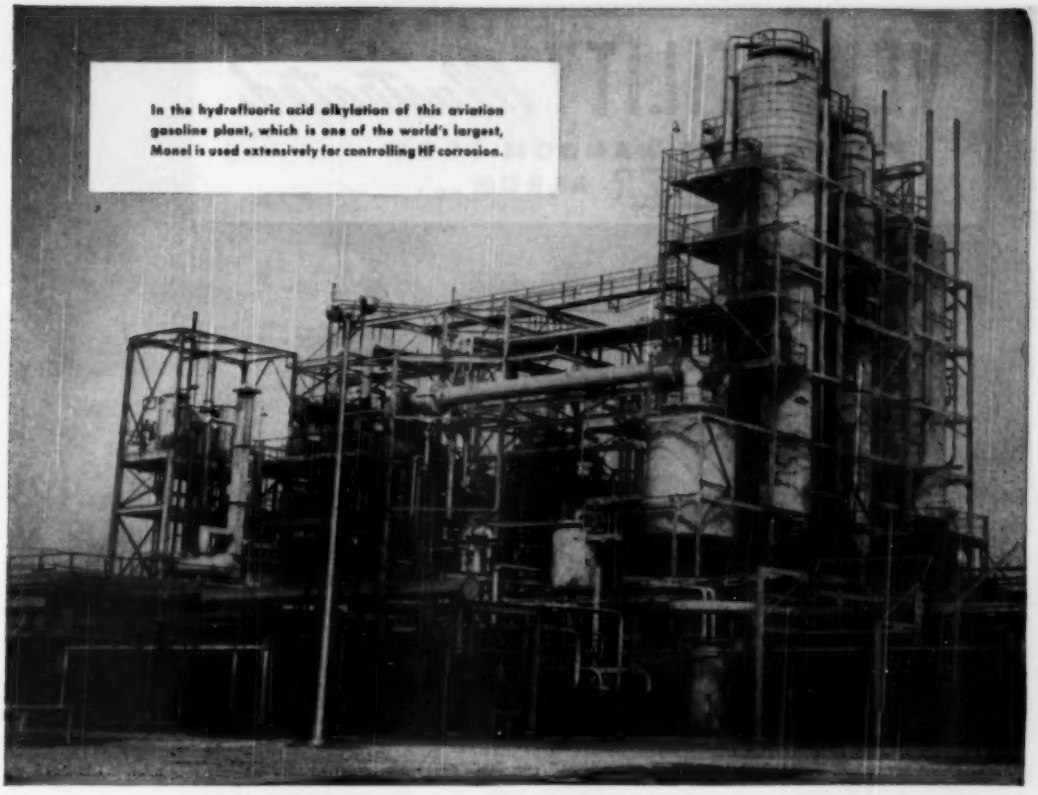

In the hydrofluoric acid alkylation of this aviation gasoline plant, which is one of the world's largest, Monel is used extensively for controlling HF corrosion.

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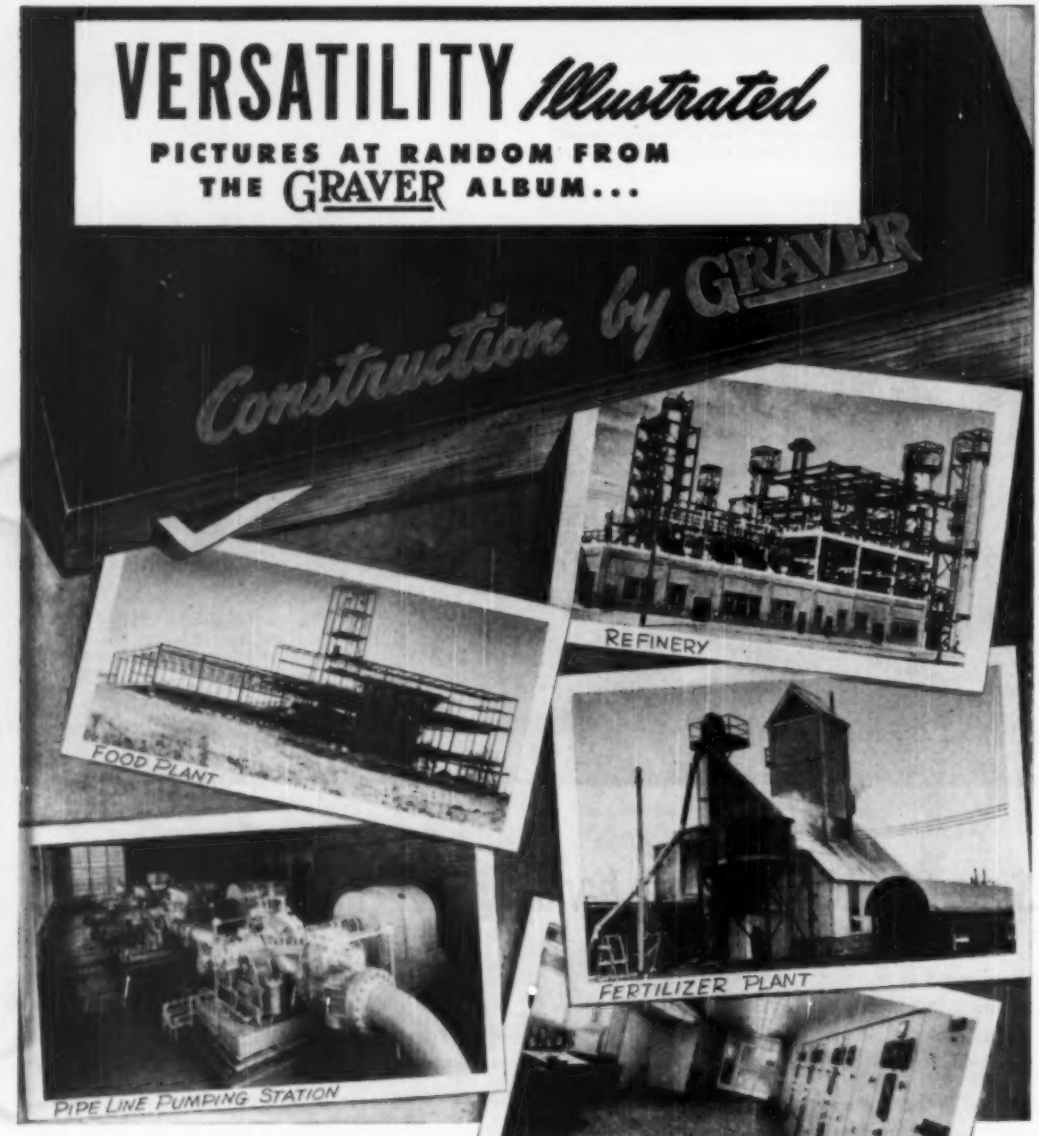

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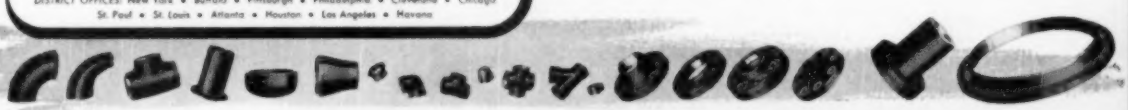

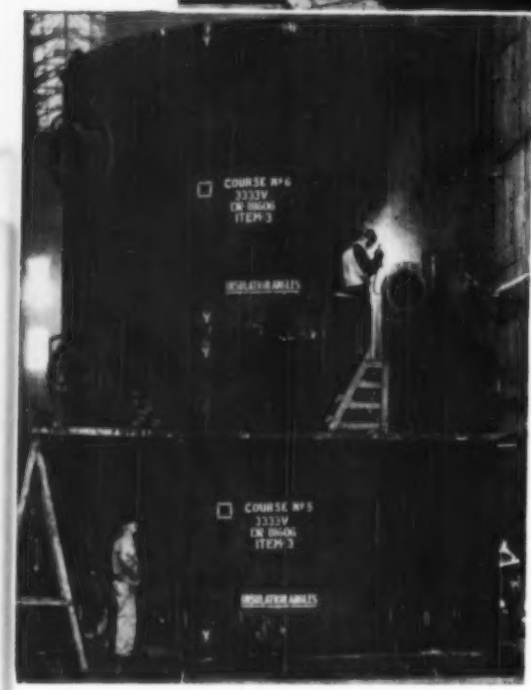

FABRICATORS OF A MILLION TONS OF STEEL

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Illustrated are two of the many types of heavy equipment built at Newport News. At the top are four of seventy 38½ foot vacuum tank casings we have built. At the left are two courses of a 116-foot fractionator tower, 18½ feet in diameter. Your inquiries are invited.

Write for illustrated booklet, "Facilities and Products."

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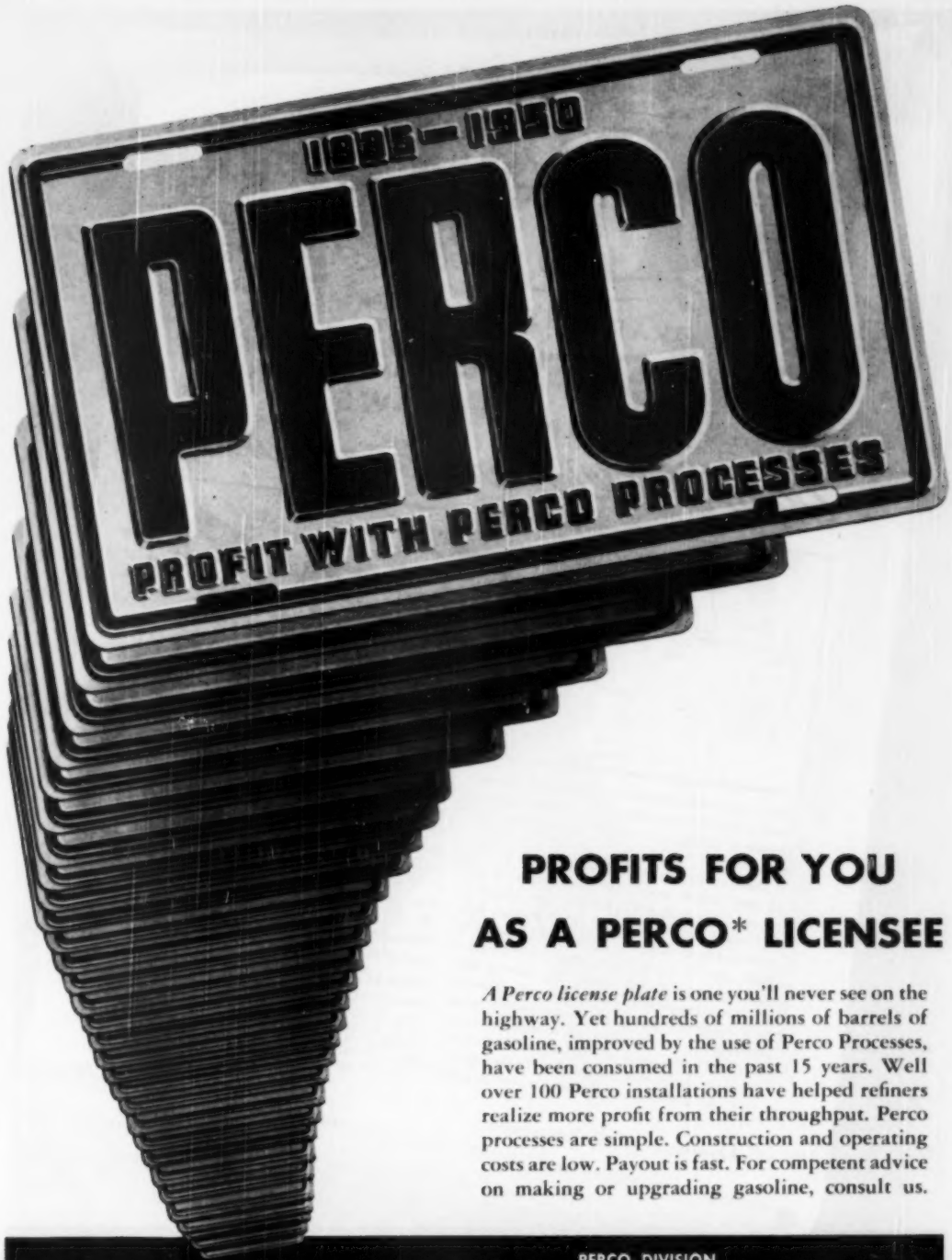

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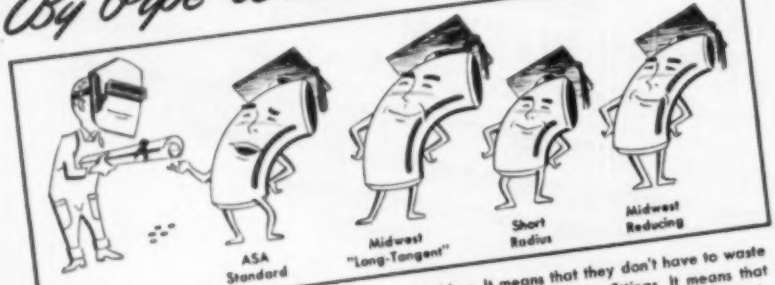

Pipe welders who know Midwest Welding Elbows have conferred upon them an honorary degree unique in piping . . . "D. A." for "dimensional accuracy".

This degree was earned for Midwest Elbows by their unique process of manufacture. In this process, developed by Midwest, the elbow is first made slightly oversize. After welding it is reheated to forging temperature and brought to final size in compression dies. This relieves forming and welding stress . . . assures true circular cross-section, controlled wall thickness and accurate radius, included arc and tangents. The elbows are beveled on special machines which cut both ends simultaneously, holding exact included angle and center-to-end dimensions.

"D. A." is a degree which means a lot to pipe welders. It means that they don't have to waste time lining up inaccurate fittings. It means that they don't have to spend time and weld metal in compensating for bad fit. And it means that they can produce better, cleaner, stronger welds with less trouble.

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Except in cases of obvious abuse, *not one* Hartzite plastic fan has ever failed. And thousands of them have been installed.

Where there is a battery of towers, one Hartzite fan goes in, then the other towers are Hartzite equipped as replacement becomes necessary. That's the established pattern.

Practically all the leading cooling tower builders specify this fan—many of them exclusively.

Extremely resistant to shock and vibration damage; practically impervious to weathering and the acids and alkalies found in oil refining; stands up well against abrasion.

Hartzell cooling tower fans of 3′ to 10′ diameter are aluminum; from 10′ to 22′, Hartzite plastic. For *dependable*, month-after-month economy and safety, *insist* on Hartzell cooling tower fans. Write —or mail the coupon below—now.

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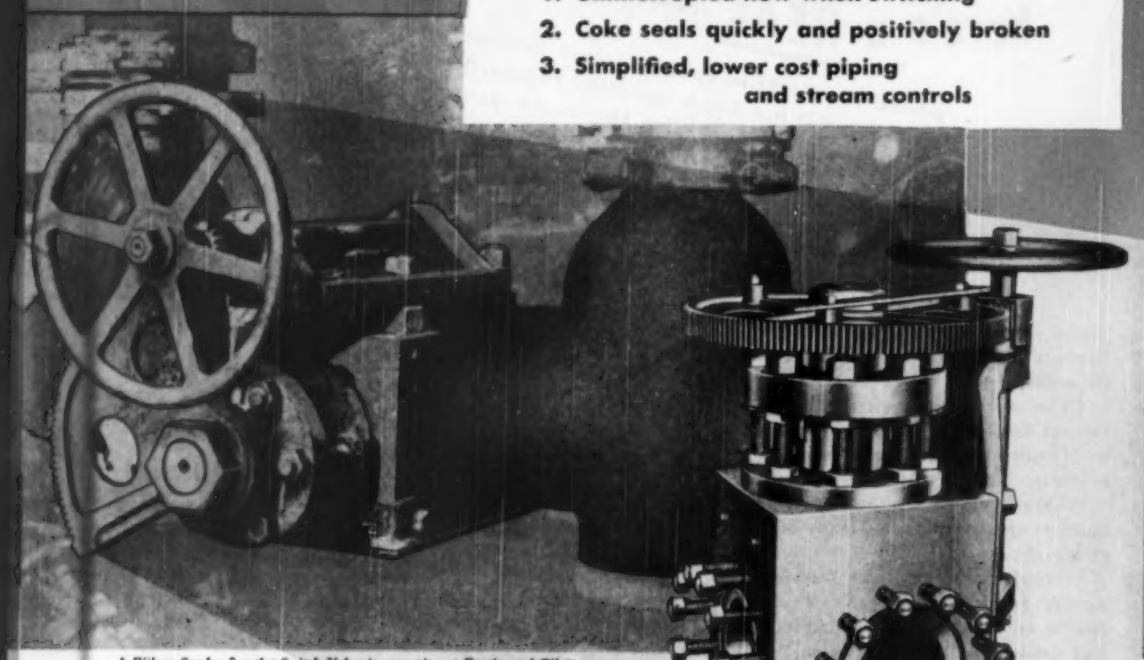
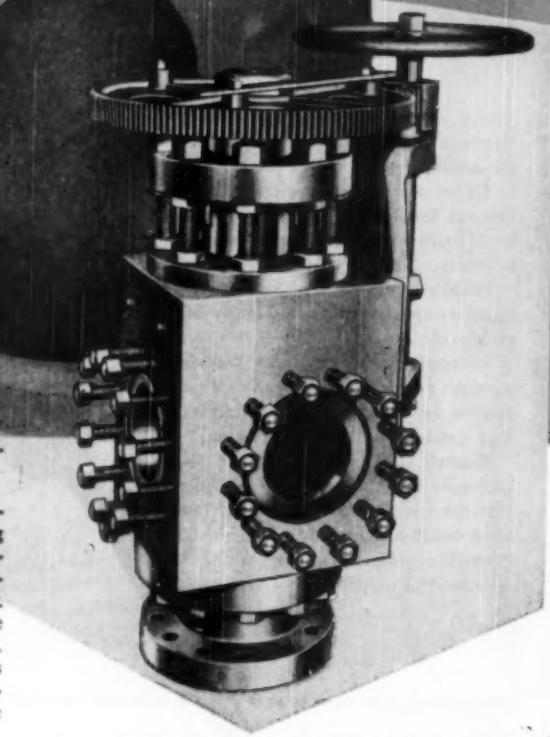


A Wilson-Snyder 2-outlet Switch Valve in operation at Continental Oil Company's, Ponca City, Oklahoma Refinery.

THE only valves combining all these features, Wilson-Snyder Switch Valves, are unequalled in coking operations where cracked tars, straight-run pitch, reduced crude, or other heavy stocks must move in a continuous stream. Designed for temperatures up to 1100° F. and pressures up to 600 P.S.I., the bodies and plugs are forged carbon or alloy steel with ground seating areas. Fluid pressure plus a thrust flange and adjusting nuts hold the plug in each valve tight against its seat. Reversing nut pressure on this flange quickly breaks the coke seal.

Wilson-Snyder Switch Valves are available in sizes from 2" to 10" with single inlet and two, three, or four outlets, or the reverse. Connections to suit your requirements can be furnished in any case.

Your local "Oilwell" representative will gladly give you complete information on Wilson-Snyder Switch Valves and pumps for all refinery applications.



Close-up view of a Wilson-Snyder Switch Valve ready for installation.

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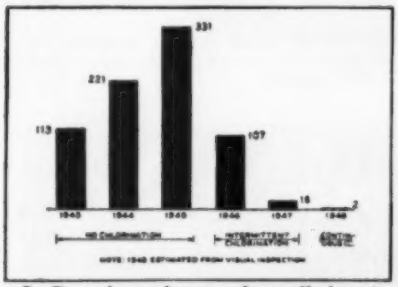
CHLORINATION BY WALLACE & TIERNAN

CONTROLS MARINE FOULING AT GENERATING STATION

LOOK AT THESE RESULTS

1. Before chlorination — mussels cover wall to depth of 3".

2. After chlorination — note bare wall.



3. Tons of mussels removed annually from intake tunnel of generating station.

It all began when a New England generating station sent down a diver for a routine inspection of the large, concrete, circulating-water, intake tunnel located approximately 13 feet below the harbor's surface. The diver discovered this intake was lined with unusually heavy growths of common mussel (Mytilus), sea moss (Tubularia), and sea anemone (Metridia).

These were expensive visitors. First, mussel accumulation created poor vacuum as the mussels lodged in condenser tubes and aggravated slime and silt formation. Then, as the mass increased in quantity, it became necessary to clean the intake tunnel every year to remove up to a maximum of 331 tons of mussels — a time consuming process that cost thousands of dollars in labor and equipment outage.

To combat these conditions a long and thorough study was made of marine fouling. As a result it was decided to use intermittent chlorination applied by Wallace & Tiernan Chlorinators. First to fall under this attack were the sea moss and the sea anemone. The tougher mussels however, still remained as numerous as ever.

In an all out effort to get rid of these trouble makers, continuous chlorination at heavier residuals was started. This treatment turned the trick and the mussels were reduced to such a low level that yearly cleaning has not been required.

These results saved the New England company thousands of dollars annually by eliminating intake tunnel cleaning, reducing condenser outages, and producing a higher vacuum with a resultant saving in fuel.

Perhaps your problem is one of slime or fouling due to some other marine organism. In any event, if biological fouling is costing you money through lowered cooling water efficiency it's a safe bet that chlorination can help.

See your nearest Wallace & Tiernan Representative now for all the details.

CD-34

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CHLORINE AND CHEMICAL CONTROL EQUIPMENT
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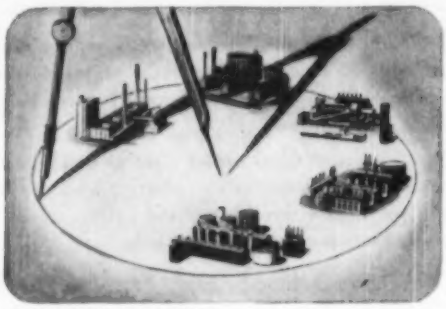
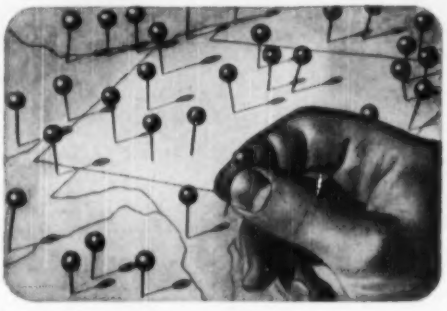
2 SOLVAY'S LONG EXPERIENCE as America's first alkali manufacturer—totaling almost seven decades—assures you of chemical products *exactly* the way they should be.



3 SOLVAY'S FIVE HUGE plants—situated where American industry is centered—guarantees a steady supply of the materials you need.



4 THE CONVENIENT, coast-to-coast locations of Solvay's 200 sales offices and warehouses make prompt delivery another feature.

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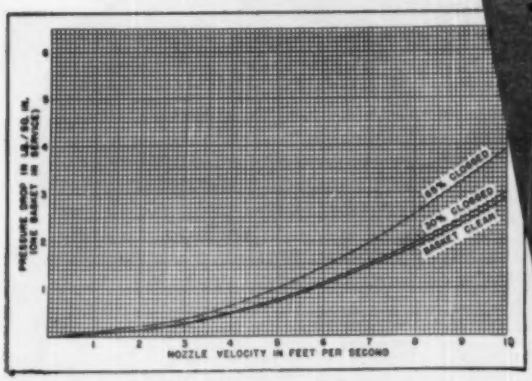
LOW *Pressure* DROP WITH



Result of a test made at the University of Pennsylvania's hydraulics laboratory to determine pressure drop in Elliott Type A Strainers.

STREAMLINE design of the strainer body and valve housings offers a minimum resistance to the flow of the liquid resulting in low pressure drop.

Larger basket area — approximately 5 to 1 ratio with standard mesh — further reduces the resistance to the liquid flow. This means a pressure drop of less than 2 feet of water at a velocity of 4.5 feet per sec when the basket is sufficiently clogged to require cleaning, as shown by the above curves plotted from tests on this strainer.

These new strainers have other advantages, too, in easier servicing, two-way gate valves that really seal, longer life, and most satisfactory operation all around. They're well worth checking into. Elliott Twin Strainers are available in sizes 1" to 24" for 125 lb pressure and 1" to 12" for 250 lb pressure. Full details in the interesting new bulletin, on request. Mail the coupon below.

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A-299-PR

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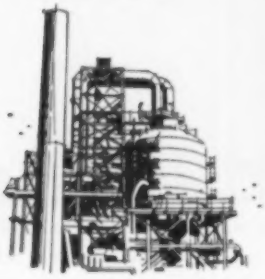

MIGHT FOR A MIGHTY "CAT"

● Might to stand up under explosive pressures without buckling—might to take super heats without flinching—might to take destructive fumes and chemical attack without corrosion . . . these are "cracking" requirements. ENDURO Stainless Steel meets them all and throws in long life for good measure.

ENDURO is right at home in oil refinery operations, because of its great strength and its great resistance to temperatures, pressures and corrosive agents. As an operator, it is tops—easy to clean, rarely requiring maintenance or repair, with a capacity for "on stream" continuous operation that makes it a producer of the first order.

ENDURO has two great virtues—an ability to keep operating costs low and to keep productivity high. Together they create PROFITS. Is ENDURO working *full time* for you—in every location needing it, that is? For better operation—go ENDURO!

✓ **CHECK ALL 12 ADVANTAGES: Rust- and Corrosion-Resistance • Heat-Resistance • High Melting Point • Low Coefficient of Expansion • High Strength • Good Dimensional Stability • No Metallic Contamination • Easy to Clean • Easy to Fabricate • Eye Appeal • Long Life • Low End Cost • *What more can be desired in a material?***

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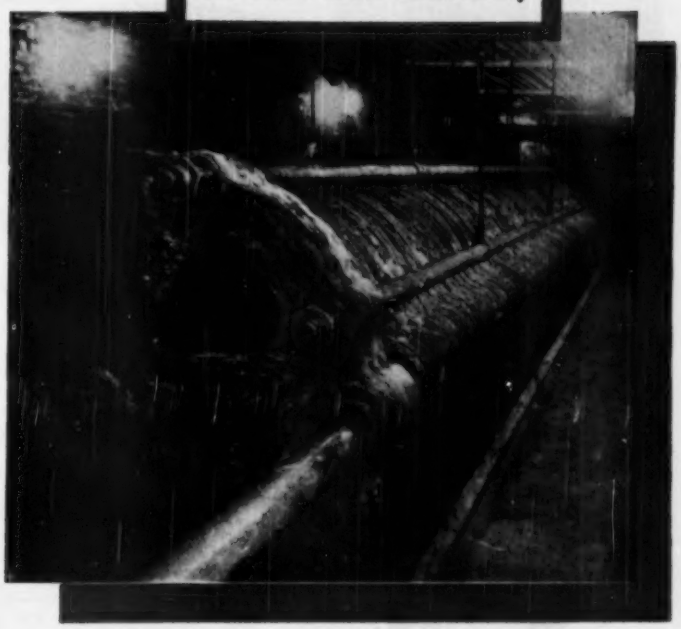
Gives You

Greater Fabric Uniformity



The greater uniformity of Mt. Vernon Extra means more efficient filtering – greater clarification of filtrates, more complete recovery of solids.

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Mt. Vernon-Woodberry's staff of textile engineers is available on request to help you with your problems in development or application of industrial fabrics.

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THESE PLUS VALUES

Of Brown Pneumatic Remote Transmission ARE INDUSTRY PROVED AND APPROVED!

Recording Receiver

NON-BLEED PILOT

Special design and construction afford rapid and dependable response . . . keep air consumption low and maintenance at a minimum.

MATCHED BELLOWS

The Sensors and Springs of Transmitter and Receiver are "matched" in calibration . . . the key to the extreme accuracy of the system.

VERSATILITY

Indicating Transmitter can be located where you want it . . . with the Receiver recording up to three variables of a generalized, control point. Control can be from the Transmitter or Receiver.

ACCESSIBILITY

Simplification of all unit and component parts allows ample working room for installation as well as maintenance.

Indicating Transmitter

Indicating Transmitter

Installations in the petroleum and chemical industries now run into the thousands . . . each a testimonial to *plus values*, the outstanding features which have made Brown Pneumatic Remote Transmission of process variables the standard of comparison.

A list of the satisfied users of this system would look like a *Who's Who* of industry. And the number of repeat purchases is proof of continuous, long-term performance!

The Non-Bleed Pilot, The Matched Bellows, the high degree of Versatility and the unusual Accessibility have combined to set high standards of safety, convenience and economy in centralized instrumentation for years. Continuing research and engineering will keep Brown Pneumatic Remote Transmission in step with your needs.

Call in your local Honeywell engineer for a discussion of its application in your plant . . . he is as near as your phone!

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4498 Wayne Ave., Philadelphia 44, Pa. Offices in more than 80 cities of the United States, Canada and throughout the world.

FOR THE PETROLEUM INDUSTRY

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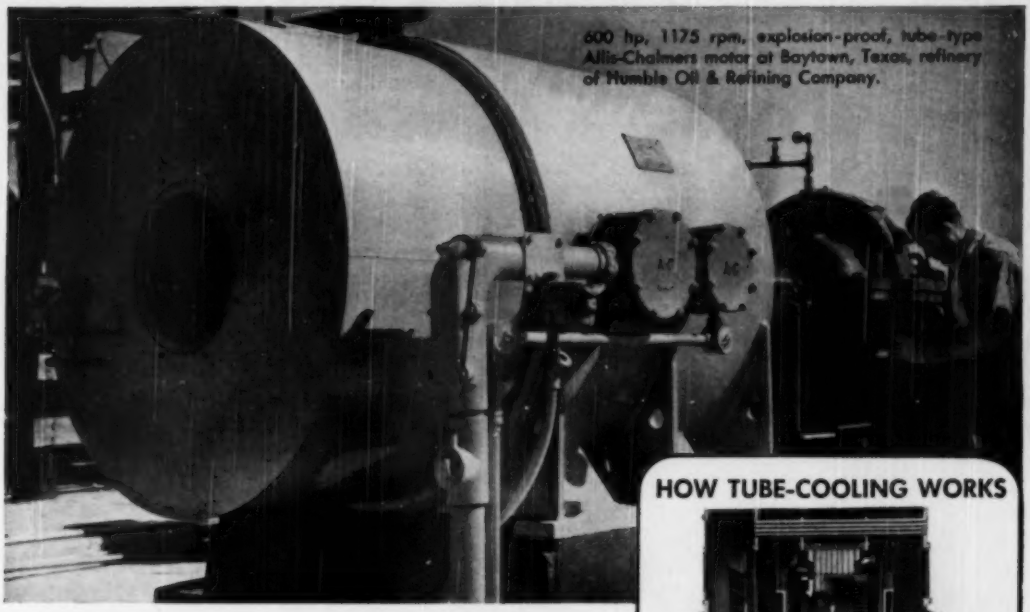
BROWN INSTRUMENTS

STRAIGHT FLOW OF AIR MAKES TUBE-TYPE TEFC* MOTORS

Self-Cleaning



600 hp, 1175 rpm, explosion-proof, tube-type Allis-Chalmers motor at Baytown, Texas, refinery of Humble Oil & Refining Company.

*TEFC MEANS—*Totally Enclosed, Fan Cooled*

YOU CAN GET THE SAME PROTECTION against explosive vapors in refinery and allied operations that Humble Oil & Refining company gets with its Allis-Chalmers tube-type motors.

This *new* type of motor is self-cleaning. Cooling air flows through straight, smooth tubes. There are no recesses to collect moisture and dirt as in conventional designs. Heat exchanger type of cooling reduces weight of the motor. The tube-type design has been adapted to the most severe corrosive conditions found in refineries or chemical plants.

It is now available with Underwriters Laboratories' label from 125 to 800 hp, 3570 rpm, with corresponding ratings at lower speeds.

For more information, get Bulletins 51R7149 and 05B7150.

A-3029

ALLIS-CHALMERS, 1062A SO. 70 ST.
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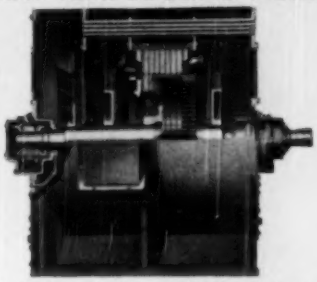
HOW TUBE-COOLING WORKS



1. Efficient air flow combined with large heat transfer area for quick heat removal. 2. Free from dirt and moisture collecting obstructions. 3. *Internal* fans circulate inside air for rapid heat dispersal. 4. *External* fan blows cooling air through tubes. 5. All electrical parts completely enclosed for maximum protection from dirt and corrosive atmospheres.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

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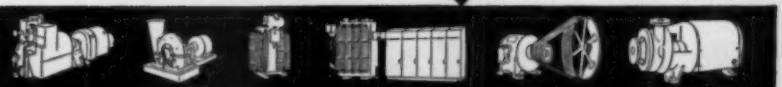
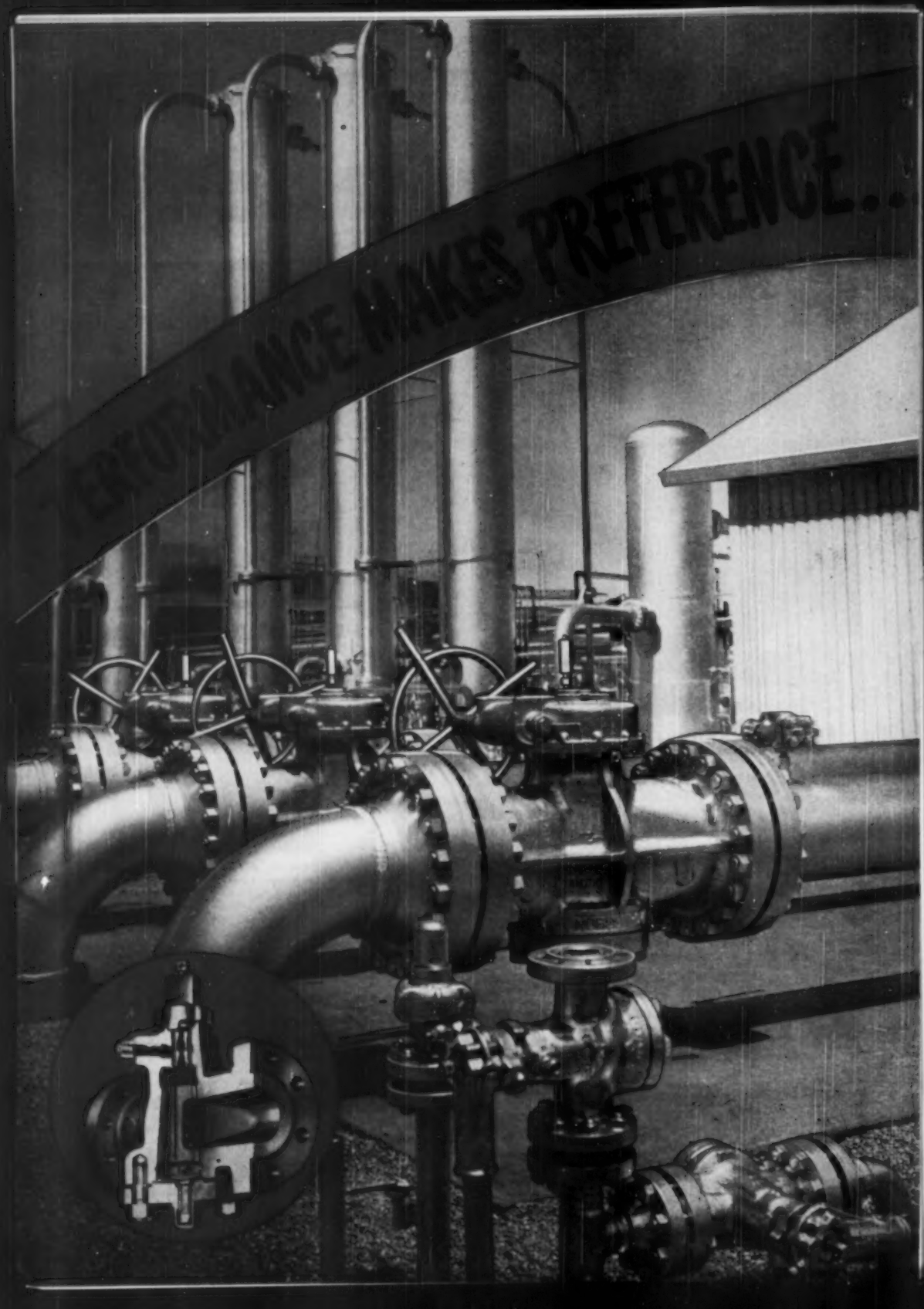
Power, Electrical, Processing Equipment for Petroleum Industry



TURBINE GENERATORS | BLOWERS and COMPRESSORS | TRANSFORMERS | UNIT SUBSTATIONS | MOTORS—*TEXROPE* DRIVES CONTROL | CENTRIFUGAL PUMPS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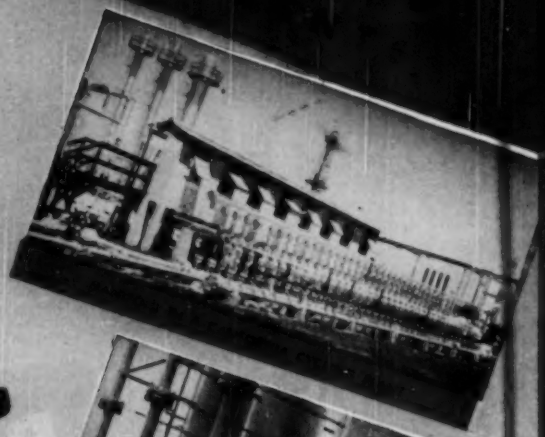
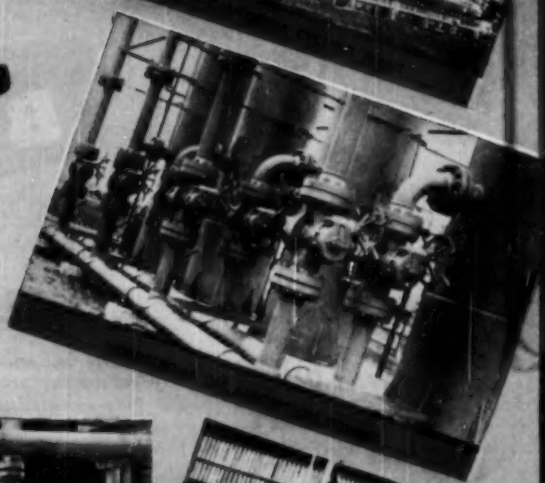
You can't take a chance with leakage in gasoline production. You insure safety by installing Nordstrom lubricated valves. Constant pressure of the lubricant seals the ports, blocks intrusion of line fluid to the seat, keeps the valve in easy operating condition and provides means of hydraulically jacking the plug if it ever becomes too tight. Nordstrom quality, Nordstrom endurance, Nordstrom performance and Nordstrom field service all combine to give you greatest value and economy. By using Rockwell Hypermatic lubricant, you get more economy than ever—*automatic lubrication*—with tremendous savings in maintenance time plus further insurance that the valves are kept in a 100% lubricated condition for unsurpassed performance.





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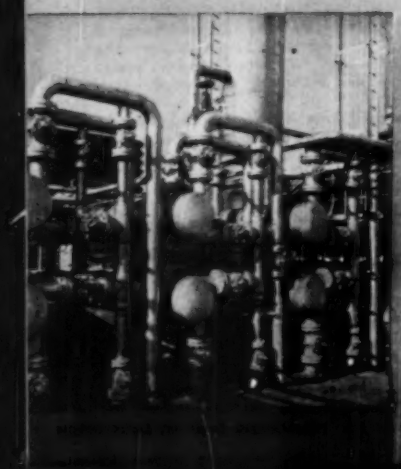

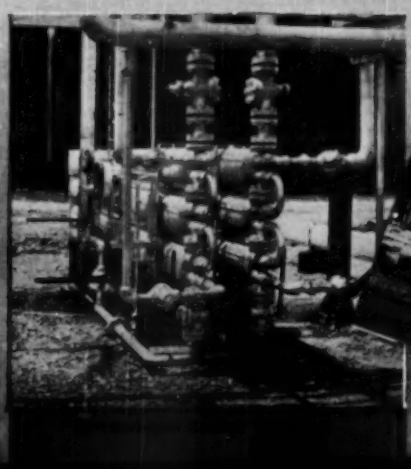

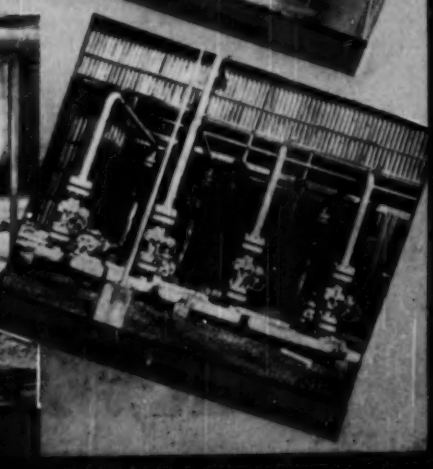

NOW! AT NO INCREASE IN COST TO YOU

Makes a good steam trap better

Nearly 650,000 Yarway Impulse Steam Traps have already been installed—proof that they are doing a good job.

Now a *stainless steel* body makes this famous little trap even *better—at no increase in cost.*

Better in *wear*, better in *service*. Users will find Yarways require less maintenance than ever. All parts are wear-resistant, practically wear-proof. There is only one moving part, a small, stainless steel, heat-treated valve. Important, too—Yarway Impulse Traps are *suitable for all pressures up to specified maximum without change of valve or seat.*

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For better steam trap performance, try *new* stainless steel Yarways.

YARWAY IMPULSE STEAM TRAPS ARE SOLD BY OVER 200 DISTRIBUTORS. THERE IS ONE NEAR YOU.

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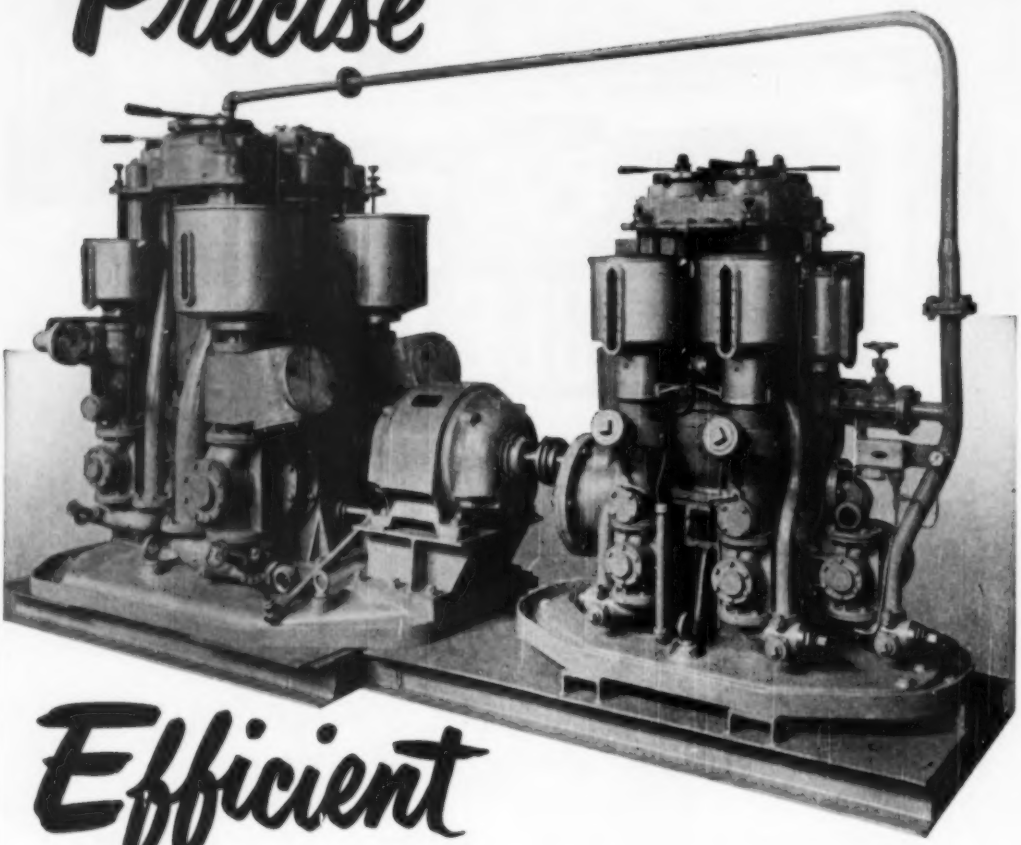

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The oil blending machines shown here are examples of the precise and efficient craftsmanship available at Sun Ship. The versatility of our organization and the diversity of our facilities enable us to build with equal success other refinery equipment, chemical plant and industrial machinery; tankers, cargo and passenger vessels. Here, too, are facilities for dry docking and for making all kinds of marine repairs.

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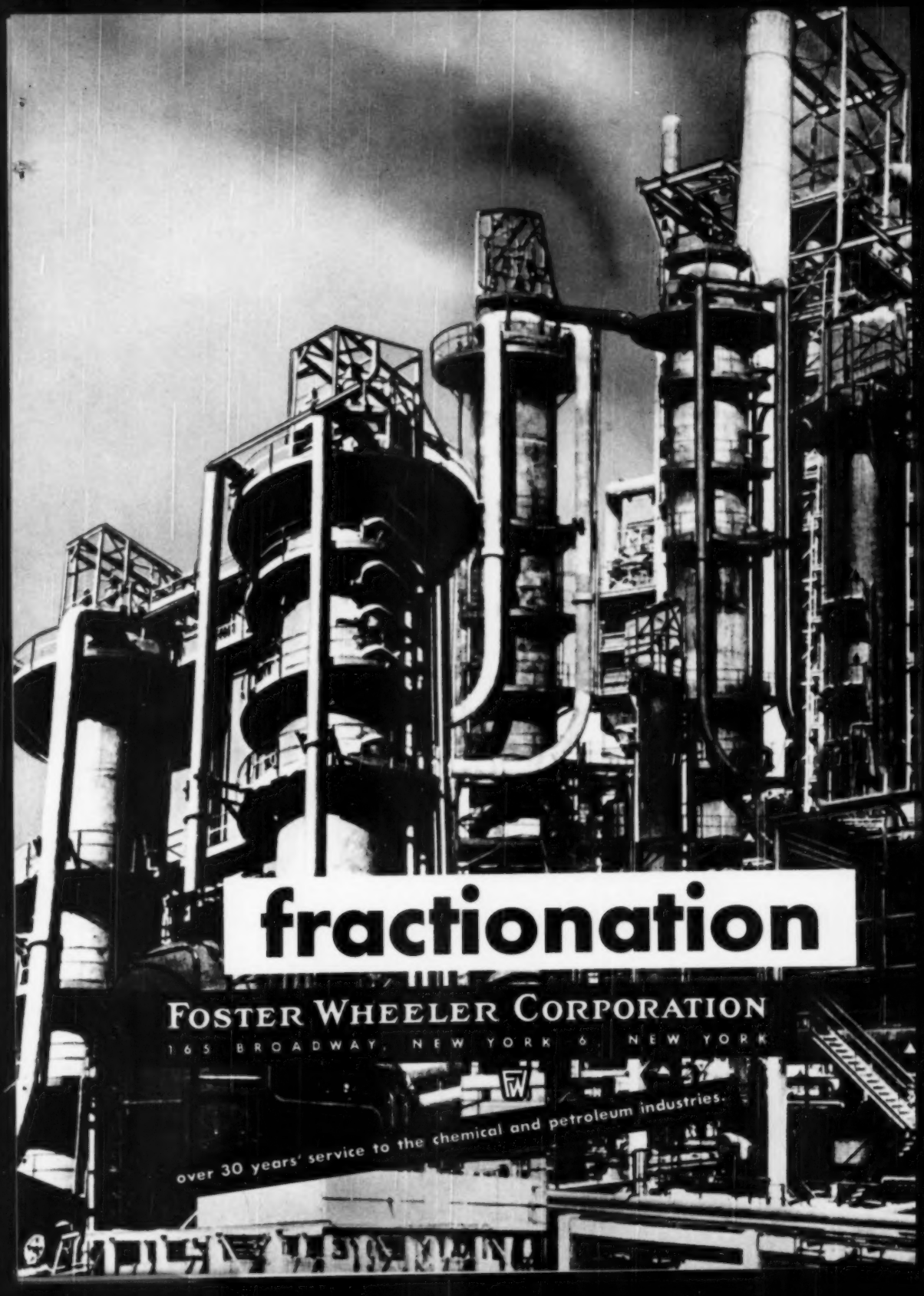
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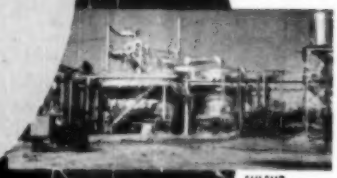

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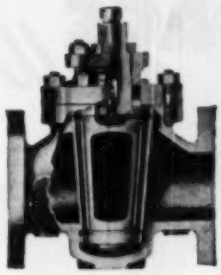
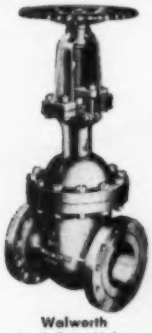
• VALVES
• PIPE FITTINGS



Walworth
Lubricated Plug Valve



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Walworth
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Walworth manufactures a *complete line* of valves and pipe fittings: all made to the highest standards of quality, both as to dimensional accuracy and metallurgical properties. In design, construction, and performance, Walworth products reflect more than a century of experience in the manufacture of quality valves and fittings.

Your Walworth distributor will give you full information on the *complete line* of Walworth steel, iron, and bronze, and special alloy valves and pipe fittings; also Walworth Lubricated Plug Valves, and Walseal* valves, fittings and flanges. Ask for this information today.

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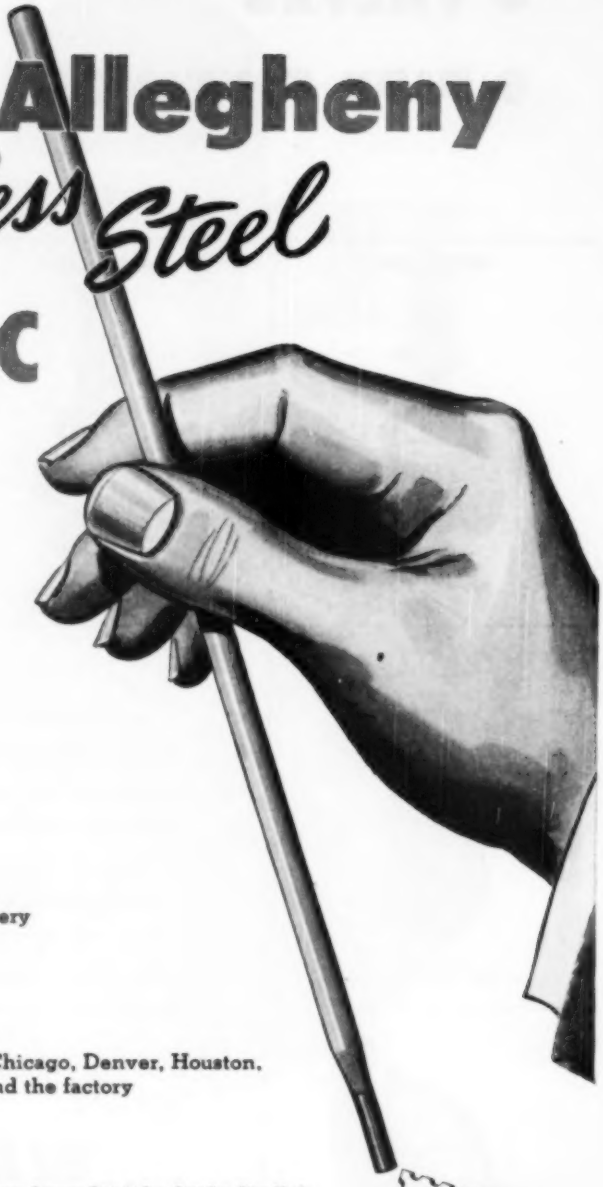

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—clean, easily removed

COATING
—resists cracking down to very short stubs

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—complete line for welding every type of stainless

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—prompt from warehouses in Chicago, Denver, Houston, Philadelphia, San Francisco and the factory at Monessen, Pa.

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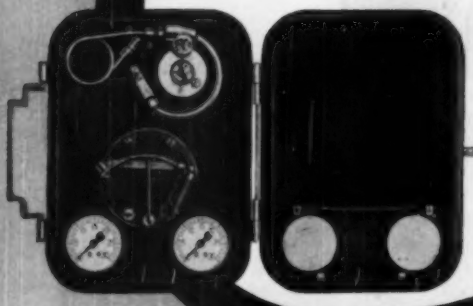
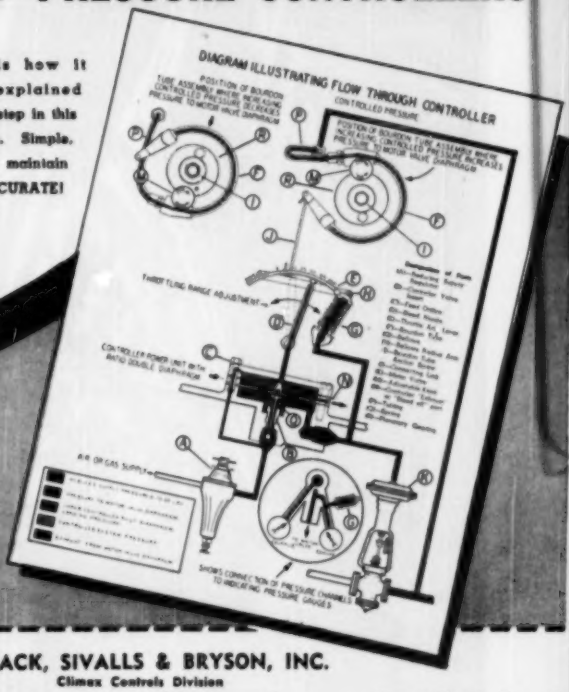
Type 1400 handles both positive and negative pressures, from high vacuum to 10,000 psi. It is adaptable to services requiring high sensitivity or to wide throttling ranges for dampening sensitivity. Overcomes hunting action which makes lined out pressure control difficult. Adjustable in the field for snap action. Bourdon-tube actuated.

BS&B

Climax TYPE 1400 PRESSURE CONTROLLERS



Here is how it works, explained step-by-step in this diagram. Simple, easy to maintain and ACCURATE!



Now you can be assured positive and sensitive response to pressure changes, with a controller characteristic usually obtained only in more expensive type recording instruments. Climax builds it right, for long service under all conditions. A multitude of special adaptations are possible... Ask your BS&B-Climax Man today!

You Can Count on Your Climax Man

His sound backlog of experience in process controls is available for your own use. He will be pleased to help you beat a tough problem. He is readily available, just check the coupon. Naturally, all inquiries are held in strictest confidence.

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I would like the complete story of the BS&B-Climax Type 1400 Pressure Controller . . . catalog, data, diagrams, prices. ☐ I want a Sales Engineer to call.

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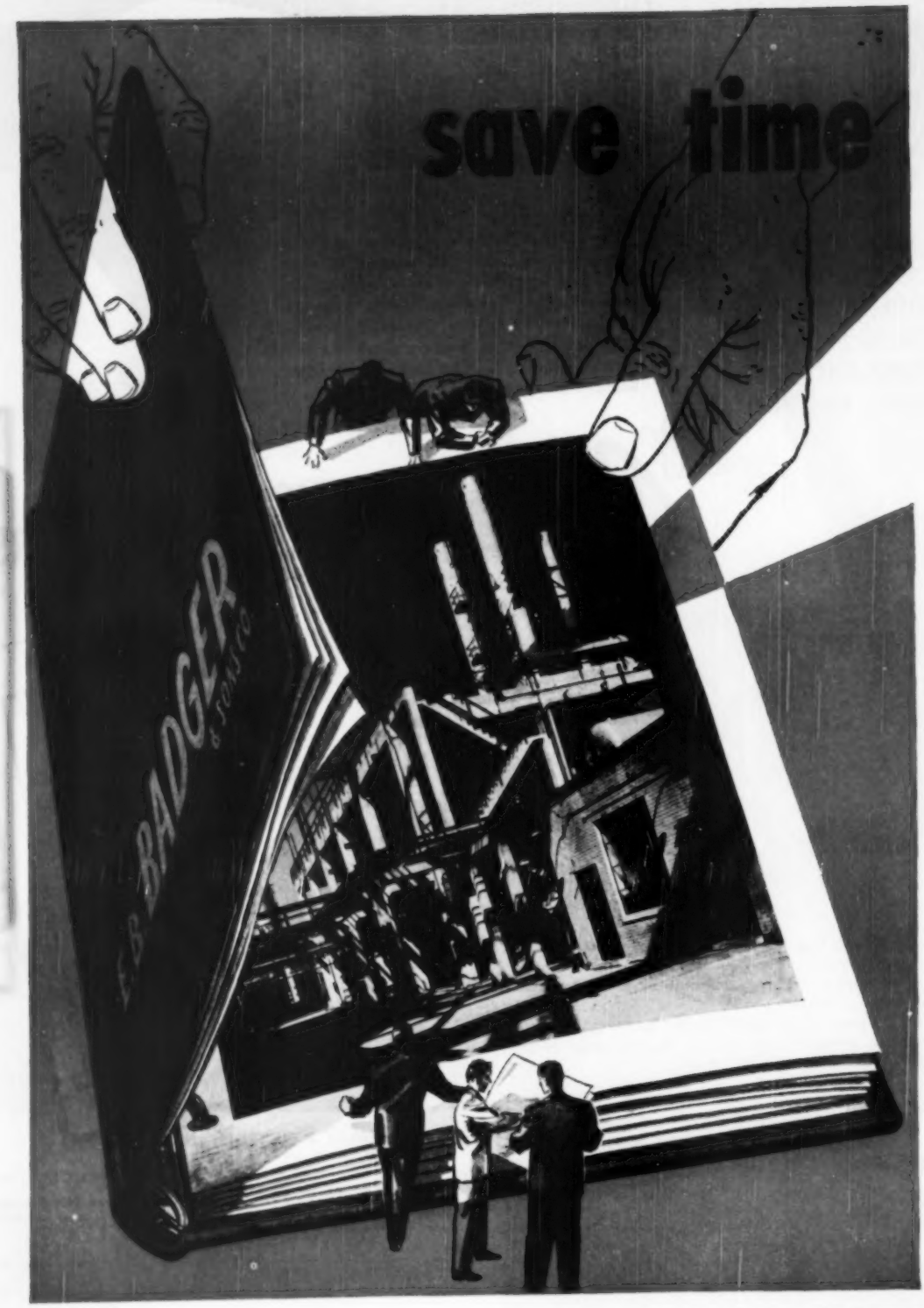
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Badger, as specialist in the petroleum, chemical and petro-chemical industries, has built a broad base of experience through decades of successful design and construction for all three.

If you are contemplating a plant for new products or for the improved production of present products, you may find in this reservoir of engineering knowledge the particular combination of ideas which will save months of process planning and enable you to enjoy competitive advantage and earlier cash return.

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Kellogg's unique devices aid in producing special types of process piping

NOT only does Kellogg fabricate virtually any type of process piping from carbon steel to alloy and alloy-lined, but it also rolls, welds and forms it from plate in sizes beyond those readily available from tube mills.

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If you are in the market for process piping of any kind, look to Kellogg!

Exclusive!!! One-Piece Giant Bends

If you require smooth interior contour on piping larger than 56 inches, it will pay you to investigate the advantages of Kellogg's *one-piece giant bends.*

To master temperature and pressure use

M. W. KELLOGG

piping and process equipment

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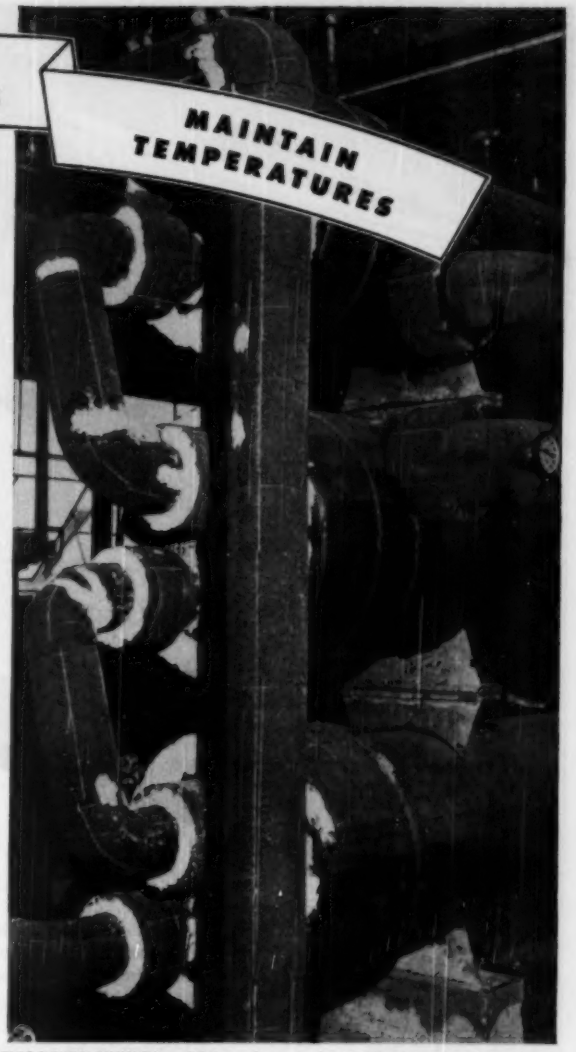
REDUCE MAINTENANCE COSTS

MAINTAIN TEMPERATURES

...with

PC Foamglas

the long life insulation



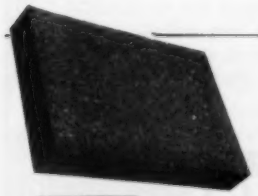
THIS PHOTO SHOWS how PC Foamglas is used to insulate process equipment and pipe lines. The material is available in standard flat blocks, curved segments and beveled lags to fit equipment sides, heads and domes, and in preformed sections for standard pipe sizes and fittings.

● It takes an effective insulating material to help maintain the exact temperatures needed for the continuous, efficient operation of process equipment. It takes a long-lasting insulating material to help keep maintenance costs down to rock bottom. More and more engineers and plant managers in the oil and gas, chemical and other processing industries have been installing PC Foamglas recently, because it meets both requirements.

The cellular glass structure of Foamglas makes it an exceptionally effective insulation. And, being glass, it has unusually high resistance to moisture, vapor, acid atmospheres and other destructive elements. The resultant freedom from repairs, maintenance and replacement makes Foamglas a truly economical insulation. When properly installed, Foamglas *retains* its original insulating efficiency.

You can get PC Foamglas Pipe Insulation in a wide range of standard sizes for indoor and outdoor piping. Covers of Foamglas for elbows, valves and other fittings can be procured from the factory, or quickly and easily fabricated in the field. For insulating tanks, towers and other vessels there are standard flat blocks of Foamglas, beveled lags and special shapes. Curved segments for heads and domes also can be obtained.

When you are figuring on insulation, make sure you have the latest information on PC Foamglas. You will find it in our newly published booklet, which contains descriptive text and photos of recent jobs, charts, tables, up-to-date specifications and installation instructions. Just send in the convenient coupon and you will receive promptly a sample of Foamglas and your free copy of the booklet.



This is FOAMGLAS®

The entire strong, rigid block is composed of millions of sealed glass bubbles. They form a continuous structure which has unusually high resistance to moisture, vapor and acid atmospheres, is noncombustible, vermiproof and odorless. In these closed glass cells, which contain still air, lies the secret of the material's long life insulating efficiency.

Pittsburgh Corning Corporation
Dept. T-70, 307 Fourth Avenue
Pittsburgh 22, Pa.

Without obligation on my part, please send me a sample of Foamglas and your FREE booklet on PC Foamglas Insulation for industrial use.

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Address.....

City.....State.....

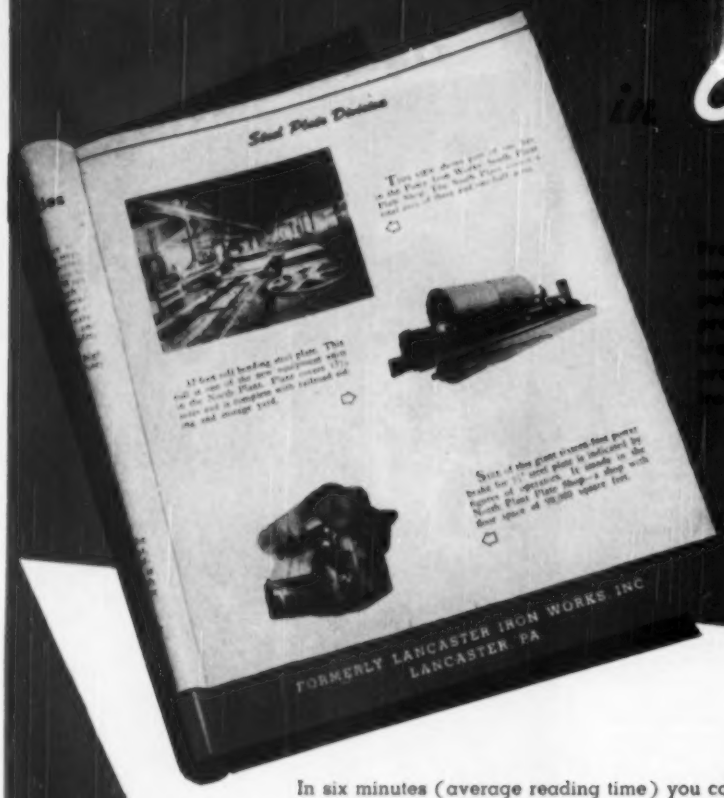
PITTSBURGH PC CORNING

FOAMGLAS INSULATION

...when you insulate with FOAMGLAS...the insulation lasts!

How you may CUT steel plate construction COSTS

in 6 minutes



Free 12-page reference bulletin—recently published—illustrates production facilities as well as some of the products of the Posey Iron Works, Inc.

In six minutes (average reading time) you can review the Steel Plate section of Posey Iron's new 12-page reference bulletin. In those six minutes, you may learn of production facilities that can be used to cut your steel plate fabrication costs . . . products that may effect processing economies in your plant.

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Write today for your free copy of Posey Iron's new bulletin. It may be your first move toward a greater reduction in steel plate construction costs than you had thought possible. No obligation.

Established Since 1910

POSEY IRON WORKS, INC.

Steel Plate Division
formerly Lancaster Iron Works, Inc.
LANCASTER, PA.
New York Office: Graybar Building

HIGHER PRODUCTION BETTER QUALITY

Operating 500 times a day with no maintenance on this surface grinding machine, Rockwood Ball Valves again *out-perform* all other makes of valves.

Picture above shows man opening the Rockwood Valve that controls the flow of the "coolant" on grinding wheel. The Rockwood Valve allows a full volume of water on the wheel giving it longer life and making it possible for the operator of this machine to produce better quality products. Because of the leak proof service, full *round* flow, and quick opening and closing features of the Rockwood Valve, production is almost doubled.

Chief engineer of maintenance at Remington Rand, Inc. says, "Until we used Rockwood Ball Valves, we were replacing or repairing our old valves at least once a week. Rockwood Valves have operated without maintenance for over a year."

Rockwood Ball Valves are today giving this same type of outstanding service in oil refineries, food, paper, textile, chemical and rubber plants, etc. Available in bronze in all pipe sizes from ½" to 2", for 300 p.s.i. working pressure.

***7** good reasons why Rockwood Valves are your best buy!* **1.** Full round open area — no turbulence in fluid stream. **2.** Leak proof after continued use. **3.** New floating ball — resists pitting, scratching and abrasion. **4.** No exposed seating surface, in open or closed position. **5.** Easy to open or close under full pressure. **6.** Installed in any position. **7.** Quarter turn (90°) opening and closing valve.

Send for bulletin V-4.
Distributors in all principal cities.

ROCKWOOD SPRINKLER CO
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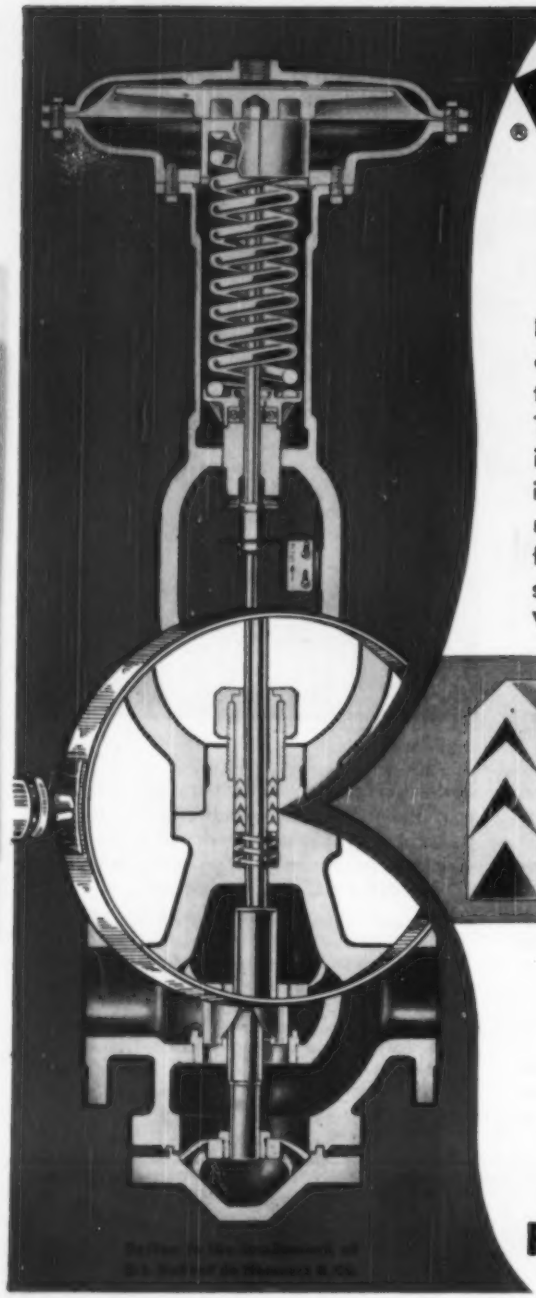
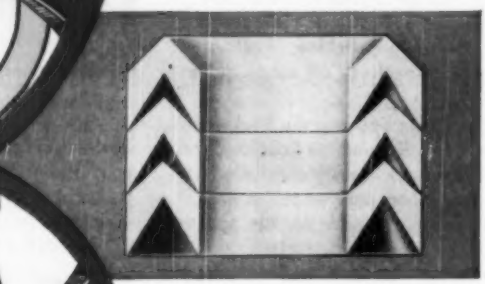
IT'S *New* AND A *Natural*



FISHER *Teflon*

V-RING PACKING

Fisher Teflon V-ring Packing has been adopted as standard available construction for all Fisher diaphragm motor valves. Teflon is tough, resilient, and chemically inert. Its smooth soap-like surface makes it ideal packing for control valves. After more than two years of laboratory and field testing Teflon in various forms and shapes, Fisher engineers decided upon the V-ring construction as ideal for packing.



Fisher Teflon packing cut in section to show V-ring construction.

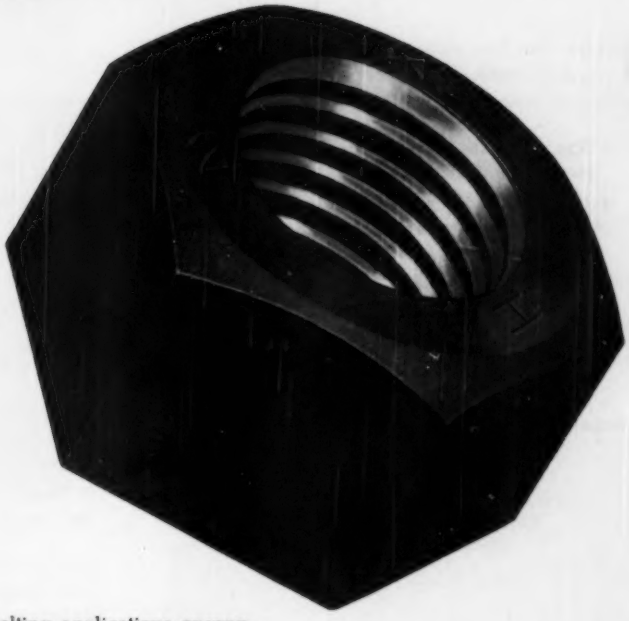
Advantages of Fisher Teflon V-ring packing:

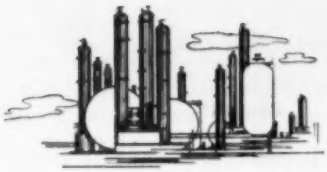
- ***Economical***
- ***Minimum leakage***
- ***Low maintenance***
- ***Reduction of packing friction***
- ***No corrosion***
- ***No product contamination***

FISHER GOVERNOR CO.

MARSHALLTOWN, IOWA

It's at its best when the going is TOUGH





For the high-temperature, high-pressure bolting applications encountered in refineries, it pays to put the Bethlehem Quenched Nut to work. For this economical nut can take it. In fact, it's at its best when the going is tough.

The Bethlehem Quenched Nut has the ability to withstand difficult bolting conditions because it is hot forged. Instead of being punched from a hot bar, like ordinary nuts, the Quenched Nut is formed by forging and extruding hot metal into a forming die. This is followed by quenching and tempering. What's the result? A nut strong enough to break virtually any stud or bolt on which it is used.

The Bethlehem Quenched Nut also has a tough grain structure. Besides, its oxidized sides put up a good fight against atmospheric corrosion, and its ground bearing surface is definitely superior to common, machined surfaces.

The Quenched Nut is made at Bethlehem's Lebanon, Pa., plant. It conforms to Grade 2H of ASTM Specification A194, and is carried in stock in bolt sizes from 3/8 in. to 3½ in. Also carried in stock at Lebanon are nuts in Grades 0, 1, 2, and 4. For additional details about the Quenched Nut, call in a Bethlehem man, or write to us at Bethlehem, Pa.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation.

BETHLEHEM STEEL

Bethlehem supplies every type of Fastener

TWO WAYS *of looking at the effectiveness of "LEAD"*

THERE ARE two ways of looking at the effectiveness of tetraethyllead in improving the antiknock quality of base fuels:

- **One way—the usual way—is in terms of the increase in octane number as shown in Chart 1.**
- **A better way is in terms of the permissible increase in compression ratio of engines as shown in Chart 2.**

Chart 1 shows that as the antiknock quality of commercial base gasolines has gone up (1936-1949),

ONE WAY

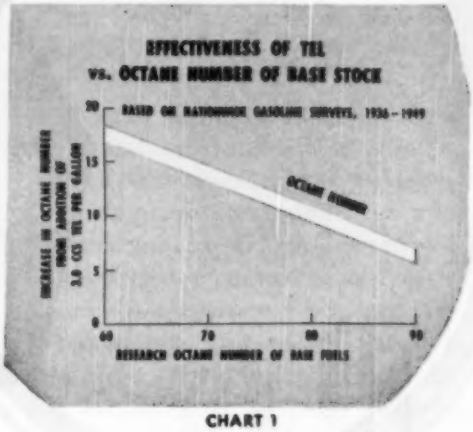


CHART 1

the increase in octane number units due to addition of tetraethyllead has become smaller. This *apparent* falling off in tetraethyllead effectiveness is due to the increased size of octane-number units at the upper end of the scale. (Chart 3)

Chart 2 shows that as the antiknock quality of base fuels has gone up, the increase in compression ratio permitted on an engine of good design by the addition of tetraethyllead has actually become greater. For the refiner seeking the most economical means of meeting the increased compression ratio of automobiles, this is the realistic way of looking at tetraethyllead effectiveness.

An even more striking illustration of the greater effectiveness of tetraethyllead, when added to fuels of higher antiknock quality, is provided by Chart 4. In this case the base fuels are mixtures of normal

CHART 4

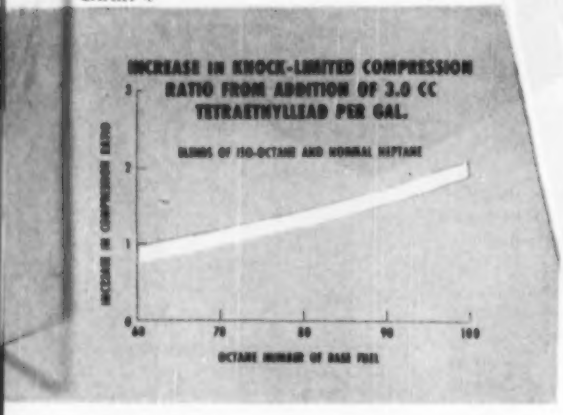
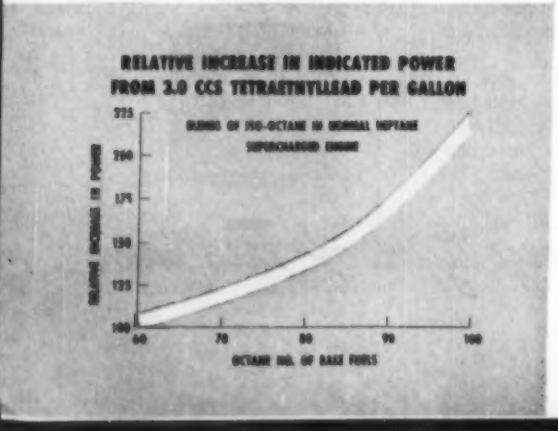


CHART 5



A BETTER WAY

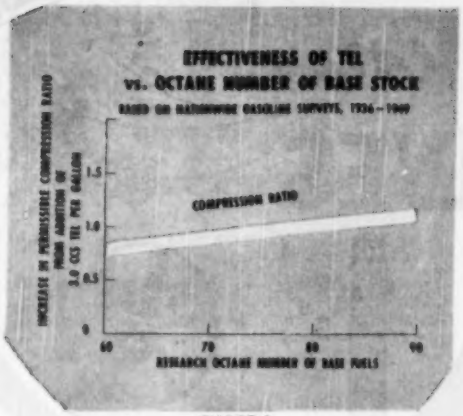


CHART 2

heptane and iso-octane in different proportions. When added to the 60 octane fuel, 3.0 cc tetraethyllead allows an increase of 0.9 compression ratio, but the figure is increased to 1.66 ratio when the same quantity of tetraethyllead is added to a 90 octane fuel.

The increased contribution of tetraethyllead to the higher octane fuels is also realized when the benefit is taken in the form of higher intake-manifold pressures (supercharging). Chart 5 shows the relative increase in indicated power made possible in a supercharged engine by the addition of tetraethyllead to blends of iso-octane and heptane. When added to the 90 octane base fuel, the tetraethyllead permits about one and two-third times as much additional power to be taken from the engine as when added to the 60 octane fuel.

The unusually large improvement in effectiveness of tetraethyllead with increase in fuel antiknock quality, as illustrated in Charts 4 and 5, is obtainable with fuels having a considerable range of hydrocarbon composition.

Later messages in this series will deal with the effectiveness of tetraethyllead when added to the four basic types of fuel hydrocarbons. Such studies serve to explain the varying behavior of tetraethyllead in commercial gasolines. More important, they point the way toward a more effective use of tetraethyllead in the future.

CHART 3. This chart shows that the units going up the octane scale become larger and larger in terms of permissible increase in compression ratio.

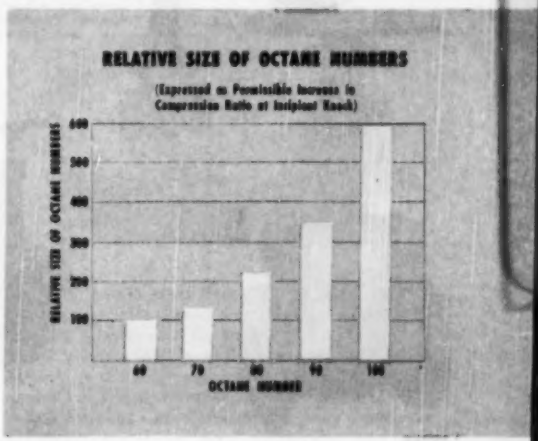

RELATIVE SIZE OF OCTANE NUMBERS
(Expressed as Permissible Increase in Compression Ratio at Incipient Knock)
RELATIVE SIZE OF OCTANE NUMBERS
OCTANE NUMBER

CHART 3

Since 1923—*continuous research to provide better antiknock service*

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RESEARCH LABORATORIES

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Do it the EASY way — *Standardize on* POWELL VALVES

When you get your valves from various sources, buying for replacement—and stocking spare valves and parts—becomes unnecessarily complicated.

But when you buy ALL your valves—Bronze, Iron, or Steel, and, if you need them, Corrosion-Resisting Valves—from ONE source, you have the answer to your flow control problems. Powell makes them all* and makes them better. Also Powell makes the *only* COMPLETE Line of Valves for Corrosion-Resistance available to Industry today.

← **Fig. 6061**—Class 600-pound Cast Steel Swing Check Valve with flanged ends and bolted cap. Disc has ample lift to permit full, straightway, unobstructed flow through valve body.

← **Fig. 1375**—200-pound Bronze Gate Valve with screwed ends, inside screw rising stem, union bonnet and renewable, wear-resisting "Powellium" nickel-bronze seat rings and disc.

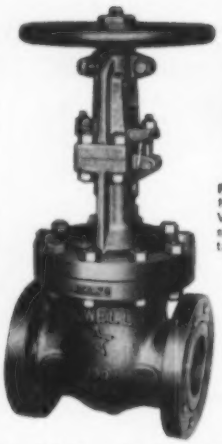
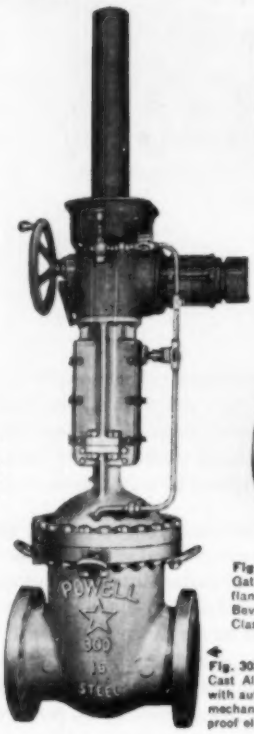


Fig. 3003—Class 300-pound Cast Steel Gate Valve with flanged ends, outside screw rising stem, bolted flanged yoke and tapered solid wedge.

Fig. 1460 — Iron Body Bronze Mounted "Master Pilot" Gate Valve with screwed ends, rising stem, bolted flanged bonnet and tapered solid wedge. →



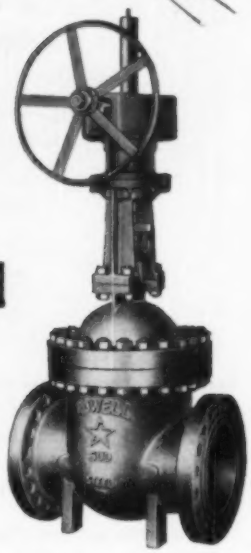


Fig. 6079 — Class 600-pound Cast Steel Gate Valve for Pipe Line Service. Has flanged ends and bolted flanged bonnet. Bevel gear operated. Also available in Classes 150, 300, and 400 pounds.

← **Fig. 3023**—Class 300-pound Cast Alloy Steel Gate Valve with automatic steam sealing mechanism. Has explosion proof electric motor operator.

***The Complete Powell Line includes Globe, Angle, "Y", Gate, Check, Non-return, Relief and Flush Bottom Tank Valves in Bronze, Iron, Steel and a wide range of Corrosion-resistant metals and alloys.**

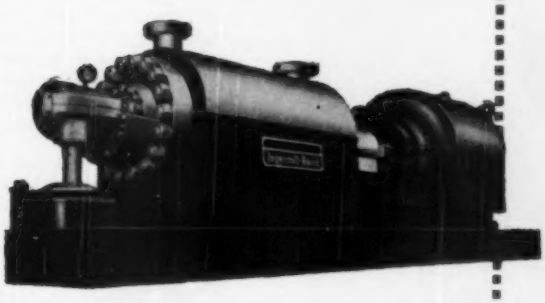
Ask your nearest Distributor—or write direct

The Wm. Powell Company, Cincinnati 22, Ohio

DISTRIBUTORS AND STOCKS IN ALL PRINCIPAL CITIES

POWELL VALVES

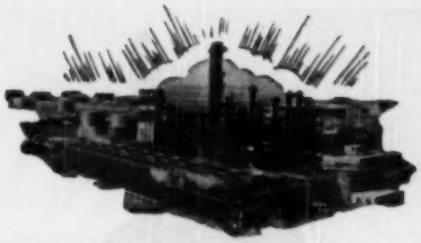
Here's why
YOU CAN DEPEND ON
Ingersoll-Rand
DOUBLE-CASE PUMPS
for really
HIGH PRESSURES



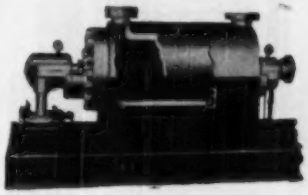
Ingersoll-Rand "double-case" pumps are built to keep pace with today's stepped-up gasoline manufacturing processes. Space-saving economy and modern appearance are combined with three characteristics of these pumps which are making them so popular with refineries and natural gasoline plants—their *dependability, ease of maintenance,* and *sustained efficiency.*

I-R high-pressure pumps, Class CHTA and CHTB, are multi-stage, single-suction, diffusor-type units, built for discharge pressures of from 1000 to 3000 psi—in capacities to 2800 gpm at temperatures up to 800° F. But *whatever* pressure or capacity you need, Ingersoll-Rand can supply a refinery pump for the job. I-R engineers will be glad to help you select the pump that best meets all of your specific requirements.

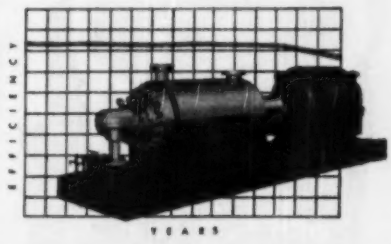
***FOR COMPLETE INFORMATION** on these new Class CHTA & CHTB pumps, call the nearest Ingersoll-Rand branch office for your copy of Bulletin 7225. I-R manufactures all types and sizes of centrifugal pumps for refinery service.*



DEPENDABILITY is probably the most important single requirement of all refinery equipment. I-R double-case pumps have chalked up performance records that speak for themselves. Many of these high-pressure units have been in service for over 12 years—with little or no attention. 40% of the pumps sold are on *repeat* orders—from users who have already proved this dependability in their plants.



EASIER MAINTENANCE, and less of it, is an inherent feature of these Ingersoll-Rand pumps. They are of "double-case" construction which permits maximum accessibility and greatly simplifies regular maintenance procedure. You save hours, or even days, of "down time" on dismantling operations too, because the entire inner casing assembly can be removed as a unit in a surprisingly short time. Precision workmanship assures interchangeability of parts.



SUSTAINED EFFICIENCY over a long period of service is assured by the care taken in the design and construction of these pumps. Carefully designed clearances and liquid passages together with selected materials, to fit the severity of the service, give protection from the effects of corrosion and erosion on efficiency. This feature of sustained efficiency keeps power consumption down and results in substantial savings over years of operation.

Ingersoll-Rand

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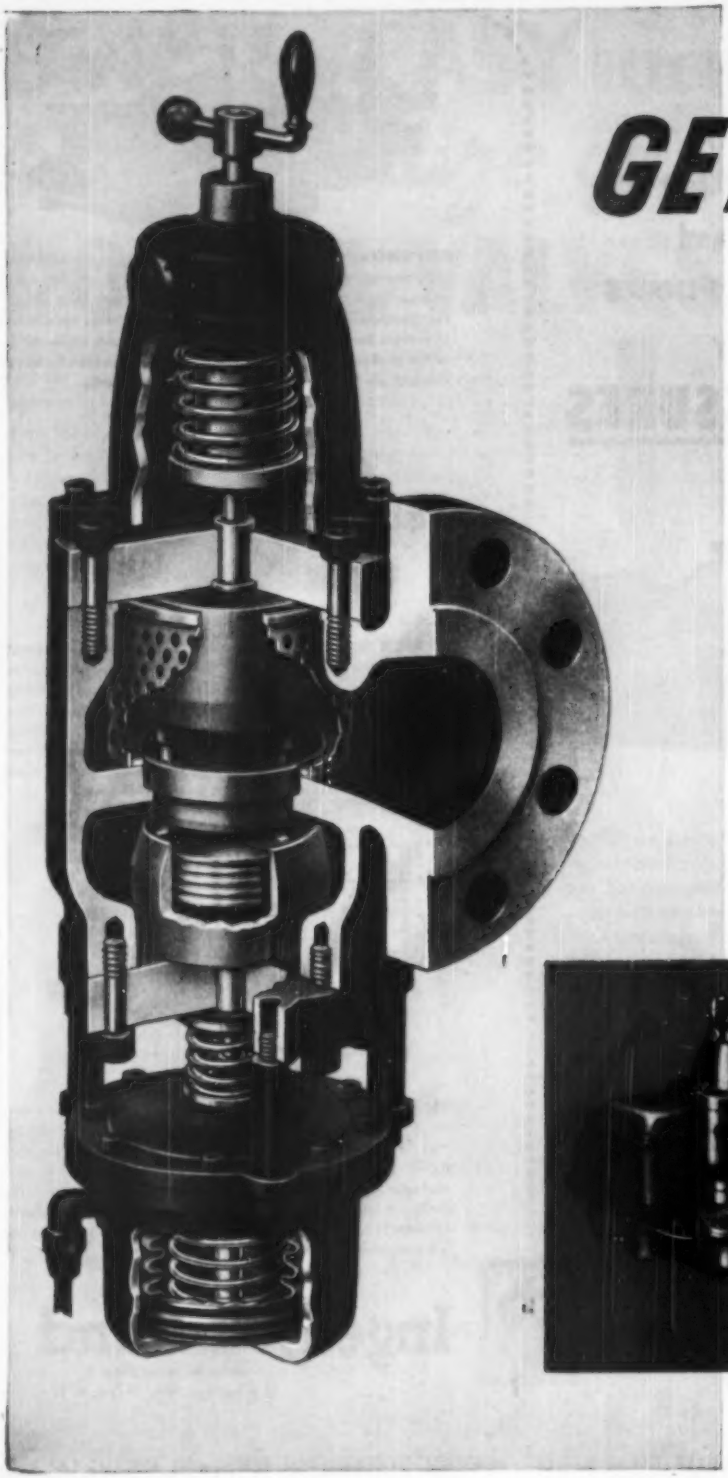

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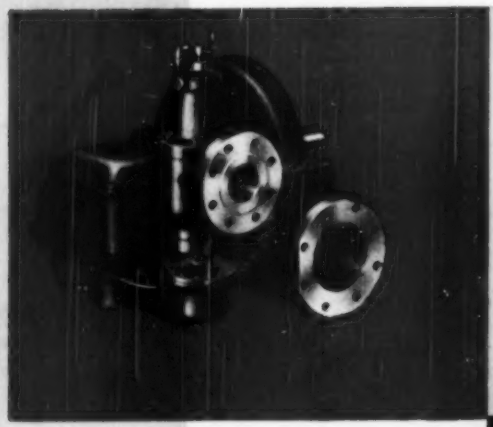

BEST IN VALVING

WITH STANDARD TURBINE DRIVES

On General Electric's standard Type DP mechanical-drive turbine, the trip-throttle valve and the governing valve are combined into one casing. This exclusive G-E feature provides a compact and neat design which simplifies piping by usually eliminating the need for a separate valve in the steam line. You get easier operation, too, because pressures across the valves are equalized. The throttle valve mechanism is ball-bearing mounted, and only hard packings are used.

POSITIVE OVERSPEED PROTECTION

A bolt-type emergency governor, mounted in the turbine shaft, actuates a trip mechanism when speed rises 15% above normal. This action trips the throttle valve closed, positively shuts off steam flow to the turbine. A convenient hand lever is also provided for tripping the valve.

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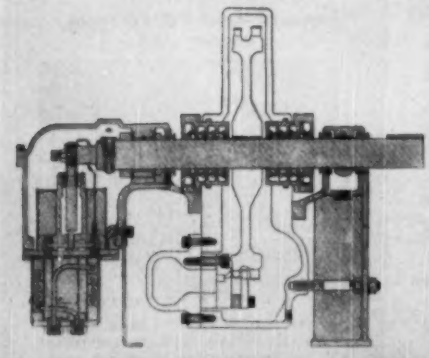
Working with the DP's powerful hydraulic governor, the governing valve gives you greater performance accuracy. The balanced reaction design reduces valve unbalance to a minimum. Relief holes equalize pressure between the valve and the guide piston of the seat. Hard packing decreases the force required to move the valve, results in smoother operation.

LONG LIFE AND DEPENDABILITY

The stainless steel stem and nitrided stainless steel valve and seat are designed to last for years. Maintenance is cut through the use of corrosion-resistant labyrinth stem sealing bushings. No soft packings are used. An easily removable monel steam strainer in the throttle valve chest halts foreign material before it can reach valve or steam parts.

Look into *all* the features of the standard DP turbine. You'll find many extras, such as the valving, which can give you the performance and savings you want from a mechanical-drive turbine. Contact your nearest G-E sales office, or write for bulletin GEA-4955. *Apparatus Dept., General Electric Co., Schenectady 5, N. Y.*



HOW STANDARDIZATION WORKS FOR YOU

In the diagram at the left, all shaded parts are interchangeable on all sizes of DP turbines. Thus, it is easy to stock spares, and maintenance costs are reduced. All models have standard shaft height and coupling fits for easy installation or re-location in your plant. Standardization cuts manufacturing expense and the savings are passed on to you in the form of extra features, usually found only on "special" turbines.

GENERAL ELECTRIC

This man *can help you*

control temperatures

accurately—economically

He's the man who can show you the proper insulation to give maximum heat and power for each fuel dollar expended

An Eagle-Picher Industrial Insulation distributor or representative can help you reduce operating expenses because he has available a wide line of insulation products—for high and low temperatures—scientifically designed for maximum thermal efficiency, and practical application. Why not let him give you more information about some of the products listed here?

These Eagle-Picher products can save you money . . . power . . . time

Insulating Felts • Supertemp Blocks • Blankets • Loose Wool Pipe Covering • Stalastic • Insulseal • Insulstic • Swetchek Finishing Cements • Insulating Cements • Fireproofing Cement Diatomaceous Earth Blocks

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Insulation products of efficient mineral wool — for a full range of high and low temperatures. Technical data on request.

2105

Here's a new product that will save you money

EAGLE-PICHER FIREPROOFING CEMENT #106

Can be mixed with water to form a stiff plastic mix for easy application on ribbed lath. Recommended for fireproofing structural steel columns, steel tank supports, skirts and equipment bases. Has high dry coverage of approximately 30 sq. ft. 1 inch thick per 100 pounds. Adds fire protection, patented rust inhibitor resists corrosion. Tested by Underwriters' Laboratories, Inc.

These efficient, versatile insulations "team up" to give perfect insulation for every major application

For a completely effective, low-cost insulation combination, you can't beat the teamwork of Eagle-Picher Mineral Wool Blankets, Supertemp Blocks, Diatomaceous Earth Blocks and Earth Fill, and Super "66" Cement. They work effectively to give your equipment highest possible thermal efficiency . . . cut operating costs by saving the maximum amount of fuel . . . and help to provide perfect, precise control over temperatures.

EAGLE-PICHER SUPER "66" INSULATING CEMENT

Super "66" is all-purpose, rust-inhibitive, extremely adhesive insulating cement. "Springy ball" pellets don't collapse after application . . . give great coverage, retain their thermal efficiency. 100 lbs. covers 65 sq. ft.—1 inch thick. Easily applied with trowel, over flat and irregular surfaces. Efficient for temperatures up to 1800° F. Reclaimable when used on equipment whose temperatures do not exceed 1200° F.

EAGLE-PICHER SUPERTEMP BLOCKS

Eagle-Picher Supertemp Blocks are lightweight (approximately 16 lbs. per cu. ft.). Can be cut easily with knife or saw to fit off-shaped areas . . . they fit snugly over minor irregularities. They're strong and have high refractory value. Withstand temperatures up to 1700° F. Conductivity at 512° F. approximately 0.43 . . . all standard sizes, from 3"x18" to 12"x36" in thicknesses from 1" to 4".

EAGLE-PICHER MINERAL WOOL BLANKETS

These blankets satisfy the need for a convenient method of quickly and efficiently insulating flat or curved surfaces on larger types of heated equipment. Mineral wool is felted and secured between flexible metal fabric. Outstanding physical and chemical stability enables Eagle-Picher Blankets to resist water steam, corrosive fumes and normal vibration.

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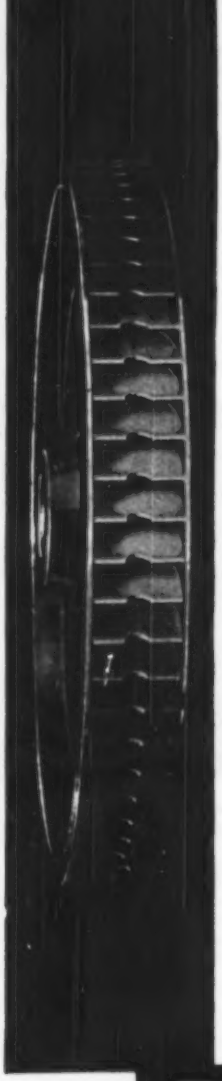
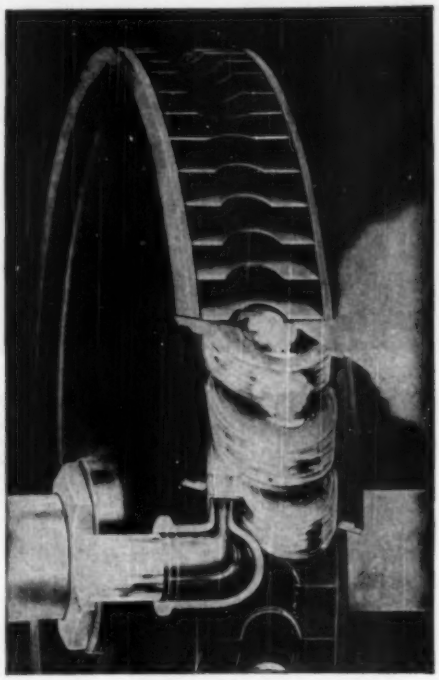
TERRY





Action of steam in Terry wheel turbine. The steam issues from an expanding nozzle at high velocity and enters the side of the wheel bucket in which its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is caught in a stationary reversing chamber and returned again to the wheel. This process is repeated several times until practically all of the useful energy has been utilized.

NO PARTS TO LOOSEN OR WORK OUT

The rotor of the Terry Wheel Turbine is a single forging of special composition steel, in which a series of semi-circular buckets is milled. There are no separate parts to become loose or work out.

The power-producing action of the steam takes place on the solid curved backs of these buckets or pockets. Therefore close clearance is unnecessary and wear on the blades forming the pockets is of little consequence, as it does not materially affect horsepower or efficiency.

For detailed information about this effective construction and its advantages, write us on your business letterhead for a copy of Terry Turbine Bulletin S-116.

T-1172

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

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are the choice of the Process Industries

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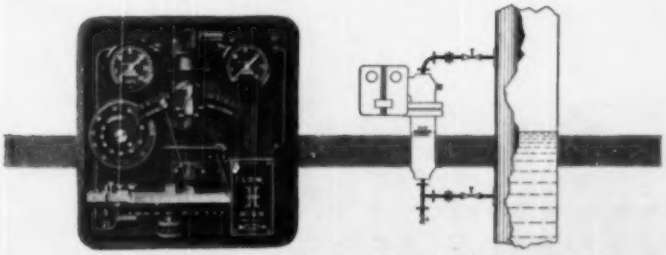

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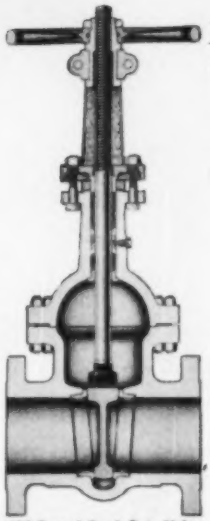

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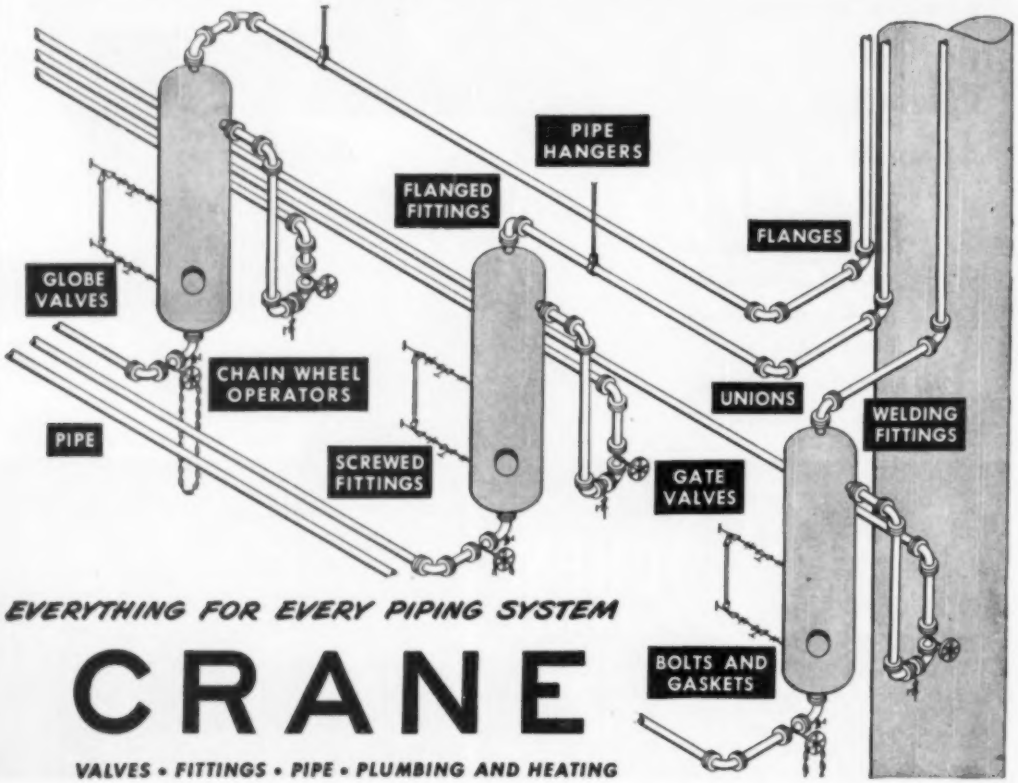

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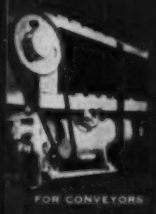
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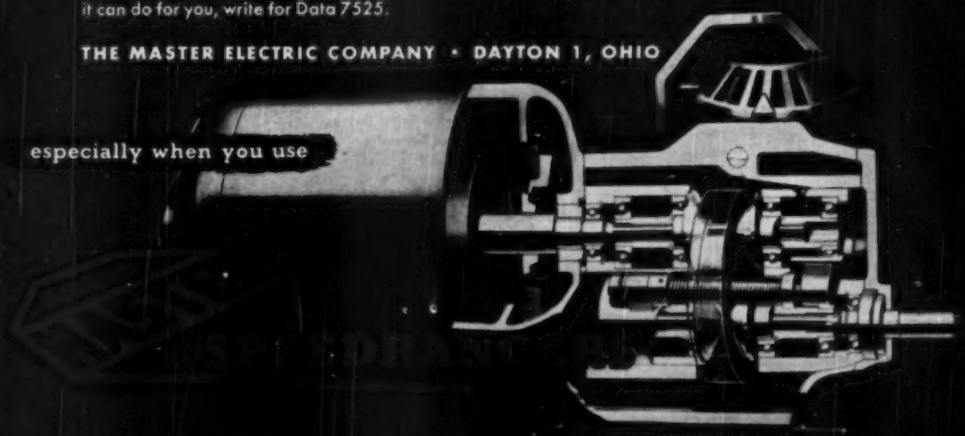

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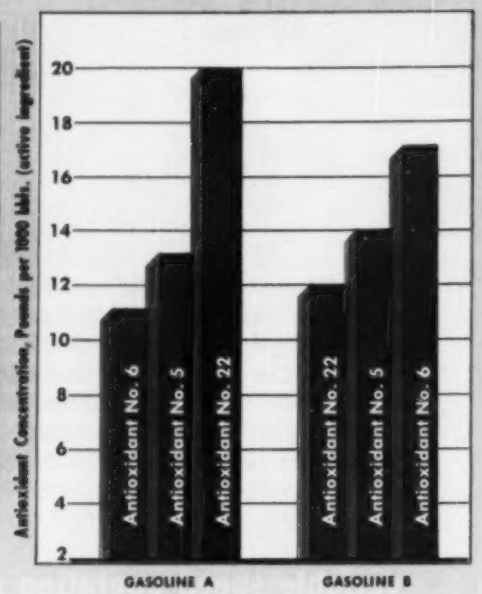

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The LOOK BOX

OIL industry leaders are becoming more and more alert to the dangers of an encroachment government control of the oil industry. The encroachment trend has been so pronounced within the past several months that company heads and others don't deserve the "leader" tag unless they have taken cognizance and actually shuddered as they read certain pronouncements from Washington.

Mr. Oil Man, Keep Alert!

"There are two roads to government control" writes J. E. Warren, Independent Petroleum Association of America president in The Independent Monthly. One is through new or extended legislation. The other is through confiscatory taxes. Both of these approaches are being vigorously explored by control-hungry or tax-thirsty members of our government."

Then Mr. Warren reviews the oil industry's battle for retention of the depletion provisions of the tax structure as applied to oil, pointing out that the House Ways and Means Committee recognized that elimination of this provision was basically unsound and unrealistic.

"The end result, in effect, of the committee's refusal to take action is to leave the tax provision unchanged," Mr. Warren declared. "But also unchanged is the desire of some to force unsound tax measures on industry regardless of the damage of such action to the public economy and national security.

"We should recognize the warning. We must be alert and vigilant. In the present instance the oil industry was fortunate in having a House committee membership that gave attention to and understood the fundamentals involved, and acted accordingly. But at some future day that committee might be wishy-washy, or just plain antagonistic toward industry and business in general. Then what would happen?

"No conclusive battle has been won. The issue is latent.

"But we do have a breathing spell while the determined advocates of ruinous taxes on the road to government control attempt to work out other approaches, possibly less obvious than direct attack. Such new approaches might well be contained in the 15 bills or resolutions that currently seek to investigate the petroleum industry.

"The action on the Kerr bill—a measure designed to clarify prior law—is another recent venture down the legislative approach to government control. In this instance the industry and the advocates of competitive free enterprise were unsuccessful. Our warning was no less crystal clear."

And here we would concur with Mr. Warren's conclusion that all industries, not oil alone, should give heed to these signposts and become and continue alert. Otherwise great will be their loss and the people's.

THE chances are that if both top research men and top management of all oil companies could have sat in during last month's session of technical men from Standard Oil Company (Indiana) then a much better grasp of this important phase of the oil industry might be had generally. Because at this session, Charles Allen Thomas of Monsanto Chemical Company gave "Some Random Thoughts on Research Administration" which rather than being random in the sense of casual or haphazard were quite pointed and should prove of much value to the industry.

Pointed Thoughts About Research

Mr. Thomas made it plain, after discussing the "personality" of a research team and the effective-

Top-of-Page-Photograph—Here is shown in an effective photo taken at night the process area of Continental Oil Company's recently opened refining plant located at Billings, Mont.

Zallea Expansion Joint News

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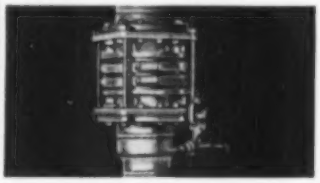

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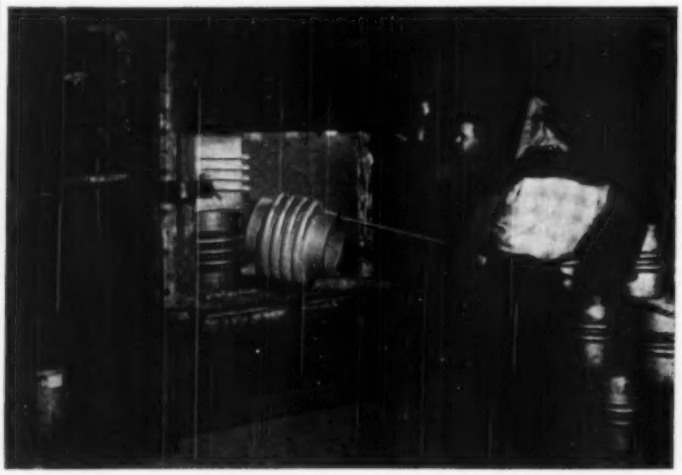

Removing stainless steel expansion joint elements from furnace after annealing at 1950° F.

ness of research team endeavor, that "mere money certainly won't buy research results, but can only provide the proper climate for research thinking." Merely putting a lot of men in motion usually is useless, he pointed out because "when a technical difficulty arises, the really important thing is to find a research mind capable of coping with the problem and giving it a chance to function."

The need for good management-research relations was stressed in Mr. Thomas' remarks. "The best research administrators are courageous in dealing with management pressures," he declared. "They understand the strong incentives which often make it seem vital to meet certain time schedules, but they know that the earliest completion of a project may result, not from frantic and futile motion, but from the application of sound research techniques."

As to research costs, Mr. Thomas observed that "we may be able to supply a host of useful figures to our designers, constructors and operators if only we apply our best research minds to the job and realize very early in the course of a project that we are going to need these data.

"Laboratory research should be just as thorough and complete as circumstances will justify and a definite effort should be made to anticipate what will be needed to make economical design, construction and operation feasible," he declared. "This should be regarded as a normal part of research. A dollar spent in the laboratory may save fifty in the new plant."

The role which research plays in industry's development is another phase of the general question which Mr. Thomas touched upon. Here is the angle of perhaps most interest to a large segment of the industry:

"The experience of American industry is that research is surely the best investment it can make . . . By application of a reasonable portion of income to well-administered research, industry cannot only buy itself an 'insurance policy' but better yet, it can forge ahead. Companies which have effective research under competent top management likely will become larger at a rapid rate.

"The important thing to realize is that well-administered research produces accelerated growth so long as free markets for goods exist," the speaker declared in giving voice to a two-pronged responsibility: "Top management and research management should look honestly at research budgets. The relation between effective research and corporate expansion should be clearly recognized and the consequences foreseen. When top management approves research budgets, it is committing itself to future financing, personnel procurement and organization. And when research proposes and accepts budgets, it, too, must be prepared to face personnel organization and facilities problems inherent in a rapidly expanding research program."

Tell Officials YOUR Views

THOSE who hold stock in American business should be more active in expressing their opinions to government officials concerning the national debt, attacks against "big business" and controls over business and industry.

This has long been the expressed opinion of PETROLEUM REFINER; so it is with considerable satisfaction that we print full and vigorous concurrence from George V. Holton, board chairman of Socony-Vacuum Oil Company, Inc., New York.

"It is within the power of aroused stockholders and employes to accomplish much more than can management," Holton said. "They have a lot of votes and the politicians know it. In numbers they will rival any other group. Your incentive must come from an appreciation of what losing the fight will mean to you and your children and from the realization that, while individually your voices may be small, in the aggregate they can be heard."

Holton urged that stockholders take an active part in politics, regardless of party, for the purpose of getting political leaders of good character, particularly in all party organizations so that regardless of which party wins there may be greater expectation of capable, honest office holders. He also urged that stockholders write to their congressmen and senators when proposals are made which seem inimical to business.

"In short, stockholders must look out for their own interests, not only by keeping a critical eye on management but by putting their shoulders to the wheel on occasions like the present when we are all so deeply mired in politically-inspired controls that our struggles to forge ahead in business seems merely to get us in deeper," Holton concluded.

Spreading From Texas

PETROLEUM REFINER last month carried a news item relating to appointment by Governor Shivers of Texas of an Oil Industry Advisory Committee composed of representative persons from each segment of the petroleum industry for the purpose of furnishing technical information in an advisory capacity to the Texas Legislative Council.

Many competent observers feel that this move is one that will help Texas iron out its own oil industry problems and do so before the federal government seeks to step in and take over. The committee is destined to become a medium by which all levels of industry can meet on common ground and tell their story and considerable good should result from its proper functioning.

Inasmuch as Texas petroleum problems are similar to those found in other states, it appears altogether possible that an efficient job by this new group will lead to like setups in other states.

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Why do the men on the firing line in a tough job of still tube cleaning, almost invariably demand Lagonda where they have any choice? It is because the Lagonda has the power and stamina to tear through the job quickly, to make a mean task easier, to complete its assignment without failure or undue trouble.

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V-293

Gains in Last Half of 1950 Foreseen by Jersey Standard

EUGENE HOLMAN, President
Standard Oil Company (New Jersey)

REMARKS made by Mr. Holman before the annual meeting of shareholders at Linden, N. J., early in June are contained in the accompanying text. Interesting forecasts of both the foreign and domestic situation as well as other pertinent observations are included in his text which, because of Jersey's rank, take on added significance.

AS FAR as 1949 is concerned, it seems to me we can all be pretty happy about the results obtained. The consolidated earnings of $269 million were next to the highest Standard Oil Company (New Jersey) has ever made, even though they were about 26 percent lower than in the record year of 1948. The company was able to pay cash dividends totaling $120 million—the highest it has ever paid. In addition, a stock dividend of one share for each 50 shares of Jersey held was distributed in 1949. Incidentally, the average 1949 earnings of the 30 largest oil companies in this country were down an average of about 26 percent which is the same drop that Jersey experienced.

Price and Volume

Our earnings in 1949 were lower for two reasons—price and volume. On an average we received lower prices for our products than in the year before. The volume was influenced by two main causes: the winter weather in much of the domestic marketing territory was so warm that fuel oil sales were low; and trade and currency restrictions abroad reduced the amount of foreign business below the level we could have reached if conditions had been more nearly normal.

Jersey and its affiliated companies during the past year or so have had to face increased difficulties in selling their oil internationally. As you know, many foreign countries are finding it difficult to obtain enough dollars through trade or by other means to buy all they would like from dollar sources. Trade and financial restrictions have been set up by many foreign states. Jersey fully realizes the balance of payments difficulties of foreign nations and is trying to do all it can to help them.

Now, what about business in 1950? This company's estimate of consolidated net earnings for the first quarter of this year was $65 million, which compares with $75 million for the same period of 1949. The best forecast of second quarter earnings is that they will be higher than for the first quarter. It now looks as though earnings in the first half of this year will be in the neighborhood of $145 million, or $4.80 per share, as compared with $137 million, or $4.54 per share, in the same period of 1949.

The general trend of all business activity is better than it was a year ago and we expect the encouraging upward movement that seems to have started will continue at least until the end of the year. The oil business, too, is better than it was for the first five months of 1949; gasoline demand has been strong, colder than average weather in March and April resulted in demand for heating oils that was 35 percent greater than during a similar period of last year. These factors, plus a shortage of coal, increased the demand for residual fuel oil.

EUGENE HOLMAN

All told, total domestic petroleum demand for the first four months of 1950 is about 11 percent greater than during the comparable period of 1949. We estimate that for the entire year, total domestic demand will average between some 6 and 8 percent more than last year. There are many factors that should aid the oil business. For example, home building is 60 percent higher than it was last year, oil burner sales are 15 percent higher and passenger car production is up 25 percent. Things like this raise our hopes and we think now that domestic production and refinery runs by the domestic industry may be as much as 400,000 or 500,000 barrels per day higher by the end of this year than at the end of 1949.

These estimates of demand depend upon not only the conditions just mentioned, but upon normal weather. While we continue to make studies of long-range weather forecasting, thus far, little practical results have come from this effort.

Foreign Picture

There is some reason to feel that the foreign trade situation looks a little better and we are somewhat encouraged by present trends. The demand for petroleum products has continued to expand. As for trade and financial restrictions, they are still with us, but recent developments indicate that we may, in part at least, be working out of some of these difficulties. For example, in April of this year we reached an agreement with the Argentine government by which we temporarily re-established our outlet in the Argentine. During this interim period, our local company and the Argentine government are attempting to work out some long-term agreement satisfactory to both parties.

More recently through lifting of rationing in Great Britain, we expect now to sell increased quantities of gasoline there. For the additional amounts sold, we will accept sterling, rather than dollar payment. The present arrangement will continue until our expanded Fawley refinery near Southampton goes on stream in 1952. We anticipate during this interim period that we will experience no difficulty in utilizing the sterling so received for the purchase of goods and services. As for the long-range picture, there still remain difficulties to be overcome and we understand talks between the British and American governments will be resumed in

Washington in order to continue efforts to reach an acceptable solution.

All this crystal gazing effort adds up to this—we are anticipating a somewhat better picture for the last six months of 1950 than the first six months.

As to restriction or elimination of oil imports, any such action by Congress might seriously limit the amounts of fuel oil available in the United States, and, in our opinion, would benefit neither our national economy nor our military security.

A great deal has been said and written about oil imports and until recently most of the information made public has come from associations of independent oil producers and from the coal industry. We think many of their arguments contain more heat than light and have resulted in mis-statements and misunderstandings.

In an effort to clear up the misunderstanding, we have recently prepared a booklet with the long title of "Facts on the Importation of Oil into the United States and the Policy of Standard Oil Company (New Jersey) on Oil Imports." Called the "Import Memo," it proves, we believe, that imported oil is a necessary supplement to domestically produced oil and does not constitute unfair competition with coal. It does provide fuel which is not economically available from domestic sources. As a supplement to domestic production it is necessary not only to fuel users, but to the domestic industry itself.

We feel most of the business the coal industry lost in the past few years was lost because of technological developments like increased use of diesel locomotives and the utilization of more natural gas. We have always been perfectly willing to compete with the coal industry on the grounds of product quality, product supply, customer preference and price. We oppose the present attempt to restrict competition by legislation.

The problems mentioned are all vitally important to this company. Any one of them, taken alone, might seem to be cause for real concern. However, I cannot remember when there was ever a really quiet period in the oil industry, or when it had no problems at all. There is always some crisis or near crisis.

But after many years the company has learned to live calmly and without panic. It tries to view all problems with calm concern, rather than to dash off in search of quick solutions. It has learned to work along the middle of the road, and to strive to reach settlements that are in the best interests of its stockholders, its customers, its employes and the public at large.

We are doing that now, and we feel sure of success and continued progress.

Tidelands Decision Imperils States' Rights

An interview with

HINES H. BAKER, President
Humble Oil & Refining Company

EDITOR'S NOTE: *In this article Mr. Baker calls upon his more than 30 years' experience as an attorney and oil man in this analysis of the Supreme Court's recent decision and its possible far-reaching effects on states' ownership of natural resources.*

Q. *What did the Supreme Court decide in the Texas and Louisiana tidelands cases?*

A. The Court decided that the two states did not own the areas off their shores within their declared boundaries. It did not hold that the federal government owned these areas but held that it had paramount rights in and dominion over them, including their resources.

Q. *How will the decisions affect the Texas free-school fund and the economy of the state of Louisiana?*

A. If permitted to become effective, the decision in the *Texas* case will be a serious blow to the school fund, since revenues from offshore lands many years ago were dedicated to this fund; and the decision in the *Louisiana* case will be a blow to that state where such revenues go to reduce the public debt.

Since 1945, Texas and Louisiana have received more than $46 million in bonuses and rentals on oil leases on offshore areas and had good reason for expecting even larger sums in the future. These revenues, and the royalties derived from oil and gas production, will be cut off unless Congressional action is taken to restore them.

Q. *Upon what theory did the Court reach its conclusions?*

A. The Court said that the United States had paramount rights in and dominion over offshore resources because it might need these resources to conduct foreign relations, wage war, and regulate foreign commerce. It advanced the novel doctrine that since the United States exercises the governmental functions of waging war, conducting foreign relations and regulating foreign commerce, property rights in the marginal sea "must then be so subordinated to political rights as in substance to coalesce and unite in the national sovereign." In the *Texas* case, the Court held that Texas owned its tideland areas while a republic but gave them up upon entering the Union in 1845 so as to be on equal footing with other states. Two fallacies in the Court's reasoning on this point are: (1) it disregards the Annexation Agreement between Texas and the U. S. reserving the tidelands to Texas when it became a state, and (2) it overlooks the fact that the Agreement does not provide that Texas shall be on an equal footing with other states.

Q. *Under the basic theory of the opinions is there danger of confiscation and nationalization of all natural resources?*

A. There is definitely such a danger. As has been said, the Court adopted a theory under which, because of national responsibility with respect to war, foreign relations and foreign commerce, the U. S. was deemed to have rights in the marginal sea transcending those of a property owner. Until the tidelands decisions were handed down, it had never been supposed that the exercise of delegated national authority in these fields could wipe out property rights of the states and by some unknown alchemy coalesce them into federal governmental powers. Obviously the same theory can be applied to allow the federal government to seize other state lands and private property for, as pointed out in Mr. Justice Reed's dissenting opinion in the *Texas* case. "National responsibility is no greater in respect to the marginal sea than it is toward every other particle of American territory." The great danger in the decisions, therefore, is that the theory advanced in them might be utilized to nationalize all state properties, all natural resource industries, and even all private property, and thus destroy free enterprise and usher in state socialism.

Q. *What problems confront offshore operators in regard to existing operations and the payment of rentals and royalties?*

A. Offshore operators are confronted with a number of problems. Uncertainties exist as to whether their leases are in effect, whether the heavy rentals and royalties can with safety be paid the states, and

FOR P·G·and E·

The Kern Steam Plant and the extension to Station P of the Pacific Gas and Electric Company represent the finest examples in the country of centralized control in steam power stations.

The Kern Steam Plant, with an installed rated capacity of 175,000 kw, recently completed for the Pacific Gas and Electric Company in Kern County, about 300 miles south of San Francisco in the San Joaquin Valley.

The extension to Station P, with an installed rated capacity of 222,000 kw, designed and constructed by Stone & Webster Engineering Corporation for the Pacific Gas and Electric Company at Hunters Point, San Francisco.

STONE & WEBSTER ENGINEERING CORPORATION

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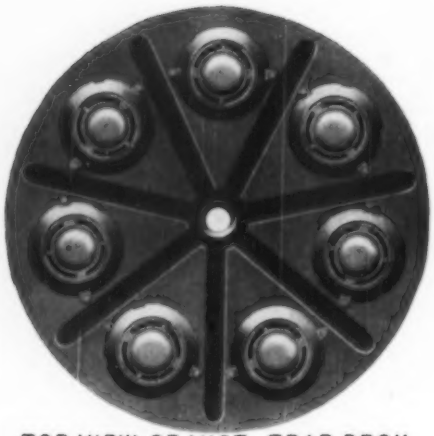
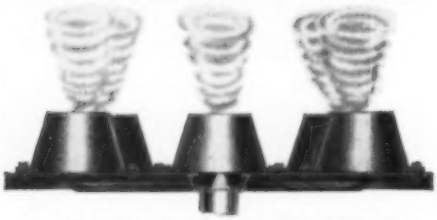
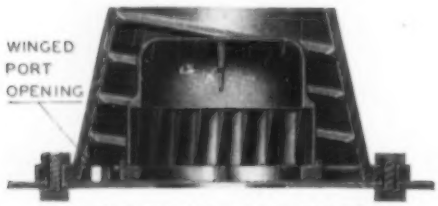
For the elimination of Liquids or Mist entrained in Gas or Oil Vapors



TOP VIEW OF MIST TRAP DECK



SIDE VIEW OF MIST TRAP DECK



SECTION OF MIST TRAP

VULCAN Scrubber or Mist Traps are made of Cast Iron, which material in itself affords a maximum absorption surface. The Trap consists of two Units—a Turbinated or Centrifugal Cap, in combination with a super-imposed conical or tapered Cast-Iron Chimney. The Chimney is constructed with downwardly directed spiral ribs on the inner surface, and having outlet ports at its base for exit of the recovered liquids. The unit is fastened to a flat steel deck and the deck welded vapor tight to the interior of the vessel shell. The steel deck is provided with openings underneath the trap, through which the vapors enter into the Centrifugal or Turbinated Cap. The velocity of the Vapors in leaving the Centrifugal Cap is greatly increased creating a cyclonic or circular travel and causing the Vapors to pass many times over the scrubbing surface of the super-imposed Chimney. At this particular point of entrance, the Chimney affords proper expansion of the gases or Vapors as they rise within the Chimney. The liquids or mists are thus entrained onto the downwardly directed ribs of the Chimney and carried off at the bottom through the port holes on to the steel deck.

The area of the ports in the Turbinated Cap and that at the top of the conical Chimney are so proportioned as to the in-put, that the pressure drop is reduced to a minimum or to a negligible amount.

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HINES H. BAKER

if so paid will continue the leases in effect. Also, operators are confronted with the risks incident to carrying on highly expensive drilling and production operations under the state leases.

These uncertainties make it necessary that Congress pass permanent legislation dealing with the whole subject of control and development of offshore areas. In view of the shortness of time, however, it may be impossible for Congress to act on all these matters at this session. Thus, as a temporary expedient, Congress might find it necessary to pass interim legislation to carry out the assurances previously given by the President and the Attorney General that the equities of the states and the property rights acquired by operators in good faith will be respected. Such legislation would, no doubt, authorize continuation of operations in accordance with the terms of leases issued by the states.

Q. *How do hazards and costs of operations and the royalty obligations under off-shore leases compare with those on uplands?*

A. In general the leases granted by the states carry the same royalty provisions as are contained in leases on uplands. This is true notwithstanding the fact that the hazards of operations offshore are much greater and the costs from three to five times as high as on uplands. Even those operators who have succeeded in finding oil fields offshore will not know for some time whether the capital they have risked will ever be returned. Offshore operators have spent about $230 million for bonuses and rentals, in exploring for oil and gas, in drilling dry holes, and in drilling and operating producing wells on the continental shelf off the Gulf Coast. Only a small part of that amount has been returned from production up to this time.

Q. *Will the decisions slow down exploration and development work and drilling in the Gulf?*

A. During 1949 and 1950, operations in the Gulf have been reduced considerably because of the uncertainty brought about by the filing of the *Texas* and *Louisiana* cases. The decisions will cause operations to be even more drastically reduced. Geophysical exploration has already come to a standstill.

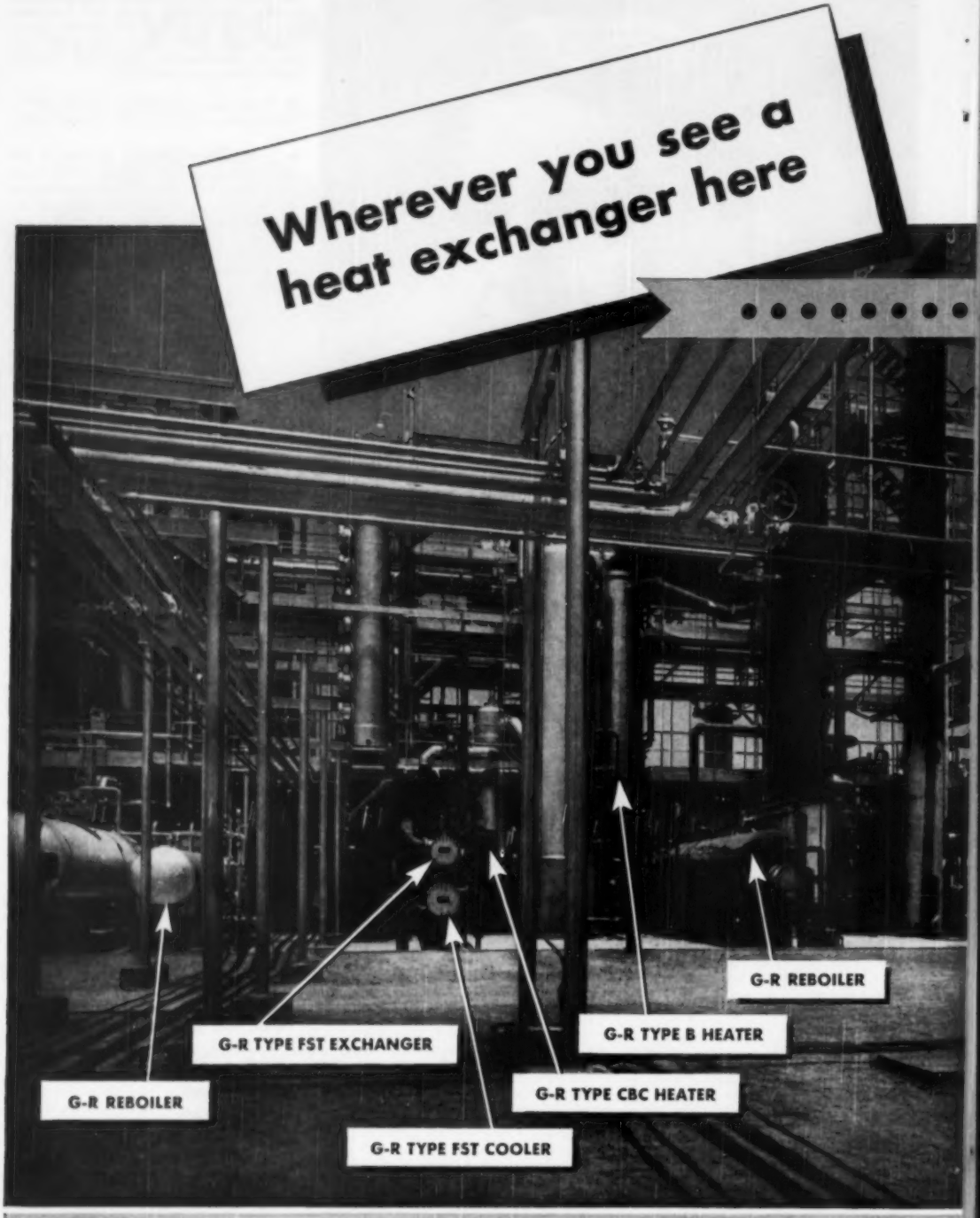
Q. *What type of legislation would offer a satisfactory solution of the tidelands problem?*

A. The Walter Bill, now pending in the House, is a measure which would seem to resolve satisfactorily the conflicting interests of all concerned. It would release to the states the offshore areas within their traditional boundaries (thereby confirming ownerships which were established over a period of about 150 years), provide a federal leasing policy for areas outside traditional state boundaries, confirm leases heretofore acquired from the states, and allow the states to extend their boundaries to the outer edge of the continental shelf for the purpose of applying their conservation regulations to oil and gas operations. This bill is supported in principle by the Governors' Conference, the American Bar Association, and other civic and patriotic organizations, and has the active and vigorous support of the National Association of Attorneys General.

A year ago Speaker Rayburn undertook to work out with the states and the Federal Government a draft of bill (later introduced as H. R. 5991) placing in the coastal states leasing authority over submerged lands within their traditional boundary lines and leasing authority in the Federal Government over the areas on the continental shelf beyond, and dividing between such states and the federal government the bonuses, rents and royalties derived from both state and federal leases. This bill outlines a sound leasing policy. It likewise offers a reasonably fair solution of the problem from the standpoint of the federal government, the states, and the bona fide holders of leases from the states.

Q. *What type of leasing policy and lease provisions will encourage development of continental shelf areas brought under federal control?*

A. A sound leasing policy should at the outset recognize that the oil and gas resources of the continental shelf can best be developed by the private petroleum industry which, through individual initiative and the risk of private capital, has supplied the oil needed for our peacetime economy and for two world wars. Equity and the public interest require that leases heretofore issued by the states be recognized. As to new leases, a desirable policy would involve the sale of leases covering units reasonably compact in size upon competitive bidding, without restrictions on the total acreage which may be held by any one operator, and upon definite lease terms with royalties fixed at one-eighth and with management of operations vested in the lessee. Leasing provisions of this type have secured development of both private and state lands in the past and are likely to encourage operations and secure the best results if applied to continental shelf areas.



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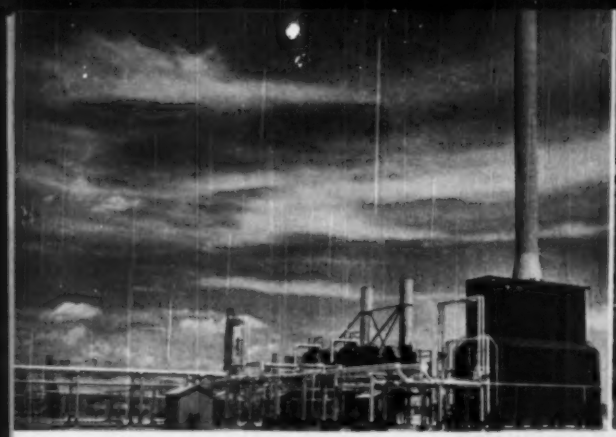

NORTH COWDEN PLANT—Above is shown the power plant area of the North Cowden gasoline plant, near Odessa, Texas, operated by Stanolind for a group of 21 owners and formally opened June 30. (See item on page 154.) Pictured are two gas-fired boilers each with a capacity of 42,500 pounds of 300-psi. steam per hour and a direct-forced heater which has capacity of 36 million Btu.s per hour. The plant can currently process 50 million cubic feet of gas daily but is planned to double this capacity when needed. Recovery is about 150,000 gallons of natural gas liquids daily.

NEW GAS PLANT—Formal opening last month of this $5.5 million Richfield Oil Corporation gas processing plant in the South Cuyama Valley, Calif., oil field marked the second anniversary of the company's discovery of oil in the valley. A processing capacity of 30 million cubic feet of gas daily will yield 150,000 gallons of liquid petroleum products and 24,000 mcf. dry gas a day. This gas is compressed and reinjected into underground oil reserves where its pressure increases the ultimate recovery of light oils from the oil reservoir. Aerial view of plant is shown in the photo above.

Refinery and Other PLANT CONSTRUCTION

(Tabulation starts on next page)

France Gets ECA Aid For Two New Cat Crackers

The Economic Cooperation Administration has agreed to help finance installation of two new cat cracking units at French refineries for the purpose of stepping up gasoline yields and minimizing production of heavy fuel oil.

In France, ECA will finance approximately $2.9 million of the $10 million cost of a cat cracker to be installed at the La Mede refinery near Marseilles and a gas recovery system at the Gonfreville refinery near Le Havre for Compagnie Francaise de Raffinage. It also will put up $1.8 million of the $10 million cost of a cat cracker for the Jerome refinery near Le Havre of Standard Francaise des Petroles.

Dow Chemical Announces Texas Million Expansion

Engineering and design work for Dow Chemical Company's $30 million expansion at Freeport, Texas, is in progress with construction to begin in the near future. Approved plans call for units to increase electric power output and production facilities of ethylene, chlorine, styrene, glycol, vinyl chloride and vinylidene chloride, raw materials essential for production of Dow's new "Saran" and "Styron" plastics as well as a wide variety of chemicals including permanent type anti-freeze.

Of the two chemical plants at Freeport, Plant A, which is situated on the Intracoastal canal, will get most of the expansion. Plant B is six miles northwest on the Brazos River.

Cities Service Plant Sets August Completion

Cities Service Oil Company estimates its $4-million compound plant at Cicero, Ill., will be completed about August 15. Located on a 42-acre site abutting the Illinois ship canal, the new plant will have a capacity for compounding and blending more than 23 million gallons of lubricating oils annually. Blending stocks will be obtained from the solvent-refined lube oil plant at Lake Charles, La., and barged up the Mississippi and Illinois Rivers and connecting waterways to the new facilities.

Carthage Completing Brownsville Plant

Construction of Carthage Hydrocol, Inc.'s, plant at Brownsville is practically complete with operations to be started in the near future, according to Frank M. Dawson, vice president.

Carthage was organized to manufacture synthetic high octane gasoline and by-products important to national defense by a new process utilizing natural gas. The entire outstanding stock of Carthage is owned by several private companies. These companies invested $21½ million, with a loan of $18½ million agreed on by the Reconstruction Finance Corporation, to complete financing of the project.

Bell Oil and Gas Company Contracts Platforming Unit

Construction is underway on The Bell Oil and Gas Company's new Platforming unit being designed and engineered for the Grandfield, Okla., refinery by Universal Oil Products Company. The unit, which is expected to be placed in operation this coming autumn, will have a nominal charging capacity of 1500 barrels per stream day of mixed straight-run and cracked gasolines.

Sohio Cat Cracker To Be Ready in November

The 268-foot Cleveland cat cracker of Standard Oil Company (Ohio) is expected to be completed in November, three months ahead of schedule. The unit will be capable of converting daily 18,000 barrels of partially-processed crude into high-grade gasoline and other light oil products.

The $4 million expansion and modernization of cat cracking facilities at the No. 1 Cleveland refinery is part of Sohio's three-year $100 million capital investment program.

Socony-Vacuum Develops Prefabricated TCC Unit

An inexpensive "package" Thermofor catalytic cracking unit has been developed by Socony-Vacuum Oil Company, Inc., in two sizes—one with a nominal thruput capacity of 3000 barrels per day of feed stock and the other of 6000 barrels. Socony-Vacuum said the new package units incorporate all the latest developments in the TCC process, including the recently-announced one which uses an air lift instead of a bucket elevator for returning the catalyst to the tops of the plants. The units are designed for small and moderate size refineries to produce high-octane gasoline.

The unit can be prefabricated entirely in shops and shipped by rail to the refinery site. A specially-braced but otherwise conventional oil well derrick serves

as the completed structure and also as a construction rig while the plant is being erected.

Southwestern Engineering Company of Los Angeles, which markets and installs the units and auxiliary equipment, offers prefabricated feed preparation, fraction and stabilization units in proper sizes to go with the prefabricated plants for manufacture of high-octane gasoline. It is estimated that complete fabricated plants of this type can be installed within 180 to 240 days after letting a contract.

Foster Wheeler Builds Dow Hypersorption Unit

Foster Wheeler Corporation will build for Dow Chemical Company its second Hypersorption unit, having a charging capacity five times that of the first unit which has been operating successfully since June, 1947. Three pure product streams, namely C-1's and lighter from the top, C-2's as the middle cut and C-3's and heavier as the bottom fraction, will be separated from the cracking plant effluent.

Vacuum Oil Enlarges Australia Storage

Several new bulk terminals are being built and existing storage and handling facilities enlarged in Australia as part of the postwar development program of Vacuum Oil Company, Pty., Ltd. When completed, the company will have increased its storage capacity about 30 million gallons or 40 percent since the end of the war.

The company recently completed a $2.3-million refinery at Altona. New terminals are being built at Rosehill, Bell Bay and Port Moresby. Construction is to begin soon at Colmslie. The terminal at Lae is completed. In addition to manufacturing and laboratory facilities being built at the company's ocean terminal at Pulpit Point, New South Wales, storage capacity is to be enlarged at Yarraville, Birkenhead, Fremantle, and Cairns.

Asphalt from New Plant

Utah Oil Refining Company has started shipments from its new $250,000 asphalt blending plant in Salt Lake City, Utah. Output of the new unit includes three major types of asphaltic products—road oils, paving asphalts or asphalt cements, and cutback asphalts, used in highway construction and repair.

Johnson Oil to Get Oklahoma Platforming Unit

Johnson Oil Refining Company will install a platforming unit at its 6000 barrel per day refinery at Cleveland, Okla., to be in operation by January 1, 1951. In blueprint stage, the unit will have a capacity of 1800 barrels per day and will process a predominantly straight-run 200-375° F. boiling-range stock. Design and installation will be under supervision of Universal Oil Products Company.

Notice

Refinery and other Plant Construction

"boxscore" which has appeared on a monthly basis for almost three years in Petroleum Refiner will, until further notice, appear quarterly. The next such tabulation will be in the October, 1950, issue.

Mathieson Hydrocarbon Pushes Kentucky Plant

Ground work was to have begun early this month on Mathieson Hydrocarbon Chemical Corporation's $17 million chemical plant at Brandenburg, Ky. To be in operation by the end of 1951, the plant will produce chemical products, including permanent type anti-freeze, out of hydrocarbons contained in natural gas transported by Tennessee Gas Transmission's pipe lines from Texas and Louisiana. (See May PR, page 67.)

Derby Oil Planning Cat Cracker at Wichita

Derby Oil Company plans to spend an estimated $2 million on the installation of a cat cracking unit at its Wichita, Kan., refinery. The unit will be utilized in the production of higher octane gasoline and will process crude cracked by a thermo-type plant. Capacity of the plant will continue to be 10,000 barrels daily. However, over the next two years, a capacity of 15,000 barrels a day is planned.

Mine Safety Appliances Dedicates New Lab

Safety equipment and instruments for use in such fields as air pollution and atomic energy are among the projects planned for the new Pittsburgh laboratory of Mine Safety Appliances Company opened June 14. The four-story lab, dedicated to the memory of John T. Ryan, international pioneer in the field of industrial and mine safety and co-founder of Mine Safety of the company, will include an experimental shop and library as well as high altitude chambers; dust, fume, and gas chambers; a wind tunnel, and an electron microscope that permits study of dusts and other substances at a magnification up to 100,000 times.

REFINERY and Other PLANT CONSTRUCTION

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
EAST									
Calif. Refg. Co.	Barber, N. J.	Crd. Cat. Crk.,	25,000 bbls.		Under Constr.	Jan., 1951	Houdry	Houdry, Braun	Braun
		Reformer,	10,000 bbls.				U.O.P.	Braun	Braun
		Alkylation	5,000 bbls.				Kellogg	Kellogg	Kellogg
		Crude Units	50,000 bbls.					Braun	Braun
		Boiler Plants	300,000 lbs./hr.					Braun	Braun
Calif. Refg. Co.	Barber, N.J.	3 Gaso. Trtng., Lead Sulfide Sweetening Plt., Reagent Plt.			Contracted			Cat. Constr.	Cat. Constr.
E. I. Dupont	Parkersburg, W. Va.	Tetrafluoroethylene Resin Plant			Under Constr.	Summer, 1950			
Freeport Sulphur Co.	Westville, N.J.	Sulfur Recovery	40 tons		Under Constr.	1950			Girdler
Kendall Refg. Co.	Bradford, Pa.	Platforming Unit	1,500 bbls		Contracted	Late 1950		U.O.P.	U.O.P.
Mathieson Hydrocarbon Chemical Corp.	Brandenburg, Ky.	Chemical Plt.		$17 million	Under Constr.	End 1951			
The Pennzoil Co.	Rouseville, Pa.	Propane-Deresin, Resin-Fract.	1,730 bbls.		Designing	End 1950		Kellogg	Kellogg
Socony-Vacuum Oil Co.	Paulsboro, N.J.	Propane Deasph.	3,950 bbls.		Completed		Juik	Badger	Badger
Socony-Vacuum	Buffalo, N.Y.	Houdry to TCC	15,000 bbls.		Under Constr.	Late Fall, 1950	Socony-Vacuum		
Socony-Vacuum	Brooklyn, N.Y.	Houdry to TCC	15,000 bbls.		Under Constr.	Late Fall, 1950	Socony-Vacuum		
L. Sonneborn Sons	Petrolia, Pa.	Antipollution, Acid		$450,000	Under Constr.	3rd Qtr., 1950		Chemico, Knowles	Keen & Wise, Chemico
Tennessee Gas Transmission Co.	Greensburg, Ky.	Stripping Plt.	600,000 mcf gas	$12 million	Contracted	Summer, 1951		Staff	Staff
United Refining Co.	Warren, Pa.	Lab. Steam Gen.	60,000 lbs./hr.			4th Qtr., 1950			Union Iron Wks.
MID-CONTINENT									
*The Bell Oil and Gas Co.	Grandfield, Okla.	Platforming Unit	1,500 bbls.		Under Constr.	Autumn, 1950		U.O.P.	
Cities Service, Del.	Cicero, Ill.	Compound Plt.	1,200 bbls.	$4 million	Under Constr.	July, 1950			Sollitt
Consolidated Gas Utilities Corp.	Cement, Okla.	Compr. Sta.	40,000 mcf		Under Constr.	3rd Qtr., 1950		Dresser	Dresser U.O.P., Brown & Lite
Deep Rock Oil Corp.	Cushing, Okla.	Cat. Cracker	5,000 bbls.		Under Constr.	July, 1950		U.O.P.	J. & L. Constr.
The Derby Oil Co.	Wichita, Kans.	Cat. Crk. Change			Planning				
Downe Oil Co.	Weston, Ohio	Lube Filtering	250 bbls.	$15,000	Under Constr.	3rd Qtr., 1950		Staff	Staff

* CONTINUED ON PAGE 73

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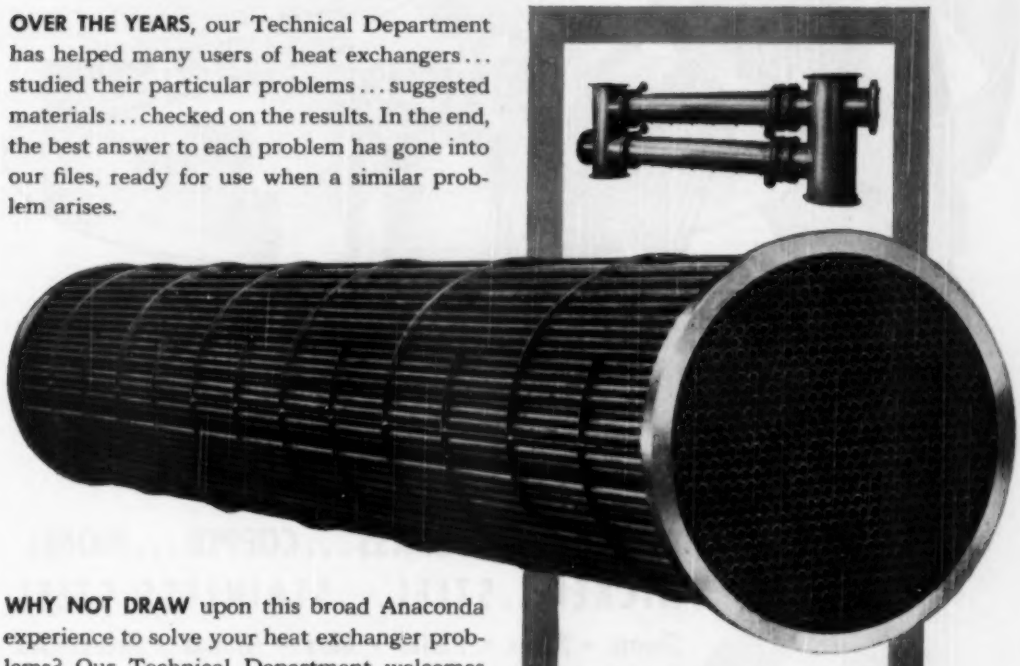

UPPER PHOTO shows Adams two-shell, single stage aftercooler designed to control temperature of compressed air and to condense water and oil vapors present. The condensate is removed by a separator. Built by R. P. Adams Company, Inc., Buffalo, N. Y.

LOWER PHOTO shows tube bundle for aftercooler. ANACONDA Arsenical Admiralty Tubes, Muntz Metal Tube Sheets and Brass Baffles.

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REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Indiana Farm Bureau Cooperative Assn.	Mt. Vernon, Ind.	Fluid Cat. Cr.	4,000 bbls.	.....	Under Constr.	1951	.....	U.O.P.	Staff
Indiana Farm Bureau	Mt. Vernon, Ind.	Gas Concen.	3,500 bbls.	.....	Under Constr.	1951	.....	.....	U.O.P.
Indiana Farm Bureau	Mt. Vernon, Ind.	Vacuum Uni	300 bbls.	.....	Under Constr.	1951	.....	.....	U.O.P.
Midland Co-Op. Wholesale Co.	McPherson, Kans.	Expansion	†22,000 bbls.	$4 million	Planned	.....	.....	.....	.....
Mississippi River Fuel Co.	Fredericktown, Ark.	Comp. Sta.	4,000 hp.	.....	Under Constr.	3rd Qtr., 1950	.....	Ref. Maint.	Ref. Maint.
National Co-Op. Refinery Asso.	McPherson, Kans.	Polymerization, Fluid Cat. Crk., Add Tankage, Utilities	†22,000 bbls.	$2 million	Under Constr.	.....	U.O.P.	Ref. Eng.	Ref. Eng.
The Ohio Oil Co.	Lima, Ohio	Ref. Prdts Term.	200,000 gals.	.....	Completed	.....	.....	.....	Poling & Bacon
Oklahoma Refg. Co.	Seminole, Okla.	Refinery	200 bbls	$40,000	Planning	Oct., 1950	.....	Lummus	Lummus
Pan-Am Southern Corp.	El Dorado, Ark.	Delayed Coke Water Cooling Tower, Steam Gen. Boiler, Coke & Loading	9,300 bbls.	.....					
Petco Corp.	Blue Island, Ill.	Houdry, Cat. Crk., LPG Recov.	5,000 bbls.	$400,000	Under Constr.	3rd Qtr., 1950	Houdry	Houdry	Clarke, Cat. Constr.
Petroleum Specialties, Inc.	Flat Rock, Mich.	Cat. Cracker	3,000 bbls.	$2 million	Planning	.....	.....	.....	.....
Phillips Petroleum	Okmulgee, Okla	Cat. Poly Unit	.....	.....	Completed	.....	.....	Staff	Staff
Phillips Pet., et al	Edmond, Okla.	Add Nat. Gaso Plant	60,000 mcf	.....	Completed	.....	.....	.....	Ref. Maint.
*The Shallow Water Refining Co.	Shallow Water, Kans.	Poly Unit	60 bbls.	$100,000	Planning	Nov. 1, 1950	U.O.P.	Koch	Staff
Shell Oil Co.	Elk City, field Okla.	Gas Extract. Plt.	100,000 mcf gas	.....	Contracted	End 1950	.....	Ref. Maint.	Ref. Maint.
*Shell Oil	Wood River, Ill.	Asphalt Load, Fac.	.....	.....	Under Constr.	Aug., 1950	.....	.....	Fluor
Socony-Vacuum	Augusta, Kans.	Houdry Conversion to T.C.C.	15,000 bbls.	.....	Under Constr.	End 1950	Socony-Vacuum	.....	.....
Socony-Vacuum	Trenton, Mich.	Houdry Conversion to T.C.C.	15,000 bbls.	.....	Under Constr.	End 1950	Socony Vacuum	.....	Braun
Standard (Ohio)	Cleveland, Ohio	Houdry to TCC	18,000 bbls.	$4 million	Under Constr.	Nov., 1950	Socony-Vac.	Bechtel	Bechtel
Standard (Ohio)	Lima, Ohio	Clay Contact	1,800 bbls.	$750,000	Under Constr.	July, 1950	.....	Lummus	Lummus
Standard (Ohio)	Lima, Ohio	Inc. Tank. Cap.	385,000 bbls.	$443,000	Completed	.....	.....	Staff	Hammond
Standard (Ohio)	Lima, Ohio	Furfural Unit	3,300 bbls.	$2 million	Completed	.....	Texaco	Lummus	Lummus
Standard (Ohio)	Lima, Ohio	Solvent Dewax.	2,500 bbls.	$4 million	Under Constr.	July, 1950	Texaco	Lummus	Lummus
Standard (Ohio)	Lima, Ohio	Vacuum Unit	9,000 bbls.	$1.5 million	Completed	.....	.....	Lummus	Lummus
Standard (Ohio)	Lima, Ohio	Propane, Deasph.	800 bbls.	$750,000	Completed	.....	.....	Kellogg	Kellogg
The Texas Co.	Lawrenceville, Ill.	Expand Refinery	†20,000 bbls.	.....	Under Constr.	April, 1951	.....	Foster Wheeler, Kellogg	Foster Wheeler, Kellogg
U.S. Dept. of Interior	Louisiana, Mo.	Demonstration oil-from-coal	80 bbls.	$4-$5 million	Under Constr.	July, 1950	.....	Koppers	Koppers
Vickers Petroleum	Potwin, Kans.	Desalting	6,000 bbls.	.....	Under Constr.	July, 1950	.....	.....	.....
SOUTHWEST									
Alba Refg. Co.	Alba, Texas	Asphalt Refining	2,000 bbls.	$150,000	Under Constr.	3rd Qtr., 1950	.....	.....	.....
Barnsdall Oil Co., Op.	Scurry Co., Tex.	Nat. Gasoline Plt.	50,000 mcf gas	$6.5 million	Considering	Feb., 1951	.....	.....	.....
Carthage Hydrocol, Inc.	Brownsville, Texas	Hydrocol	87,000 mcf	.....	Under Constr.	Summer, 1950	Hydro-Res., Inc. Texaco	McKee, Hydro-Res., Inc.	McKee
Del Rey Petroleum Co.	Chesterville, Tex.	Pressure Absorption Plant	25,000 mcf	.....	Under Constr.	.....	.....	O. L. Olson	Ole Olson
*The Dow Chemical	Freeport, Texas	Expansion	.....	$30 million	Engineering	.....	.....	.....	.....
Dow Chemical Co.	Freeport, Texas	Ammonia Plant	100 tons	$5 million	Planning	Late 1950	.....	.....	Austin
El Paso Natural Gas.	Crane County, Texas	Compressor Sta.	4,400 hp.	$1.27 million	Under Constr.	3rd Qtr., 1950	.....	Staff	Staff
E. I. DuPont de Nemours Co., Inc.	Victoria, Texas	Chemical Intermediate for Nylon	.....	.....	Design	Early 1951	.....	Staff	Staff
Esso Standard Oil Co.	Baton Rouge, La.	Main Office, Cafeteria	.....	.....	Under Constr.	July, 1950	.....	Bodman & Morell, Staff	Staff, Harris
*Ethyl Corporation	Baton Rouge, La.	Pilot Plt. Bldg.	.....	.....	Under Constr.	Aug., 1950	.....	Staff	Pioneer
Fullerton Oil Co.	Snyder, Texas	Refrig. Nat. Gaso. Plt.	40,000 mcf	.....	Under Constr.	July, 1950	.....	.....	Hudson
Humble O&R.	Baytown, Texas	Roof Replacing of Butyl Bldg.	.....	.....	Under Constr.	Aug., 1950	.....	Staff	Tellepsen
Humble O&R.	Baytown, Texas	Miscl. Facilities	.....	$1 million	Projected	.....	.....	.....	.....
Humble O&R.	Jourdanton Field, Texas	Gasoline Plant	26,000 mcf	.....	Completed	.....	.....	.....	Hudson
Humble O&R.	Baytown, Texas	Research Bldg.	.....	.....	Under Constr.	Aug., 1950	.....	Voorhees-Walker	Knutson
Humble O&R.	Baytown, Texas	Mech. Maint. Bldg.	.....	.....	Under Constr.	Sept., 1950	.....	Ferguson	Bellows
Magnolia Pet.	Beaumont, Tex.	Thermofor Cat. Cracker	15,000 bbls.	.....	.....	1950	.....	.....	.....
Magnolia Pet. Co.	Beaumont, Tex.	Two Houdry's to T.C.C.	30,000 bbls.	.....	Authorized	Late 1950	.....	.....	Lummus
Mathieson Chem. Co.	Pasadena, Texas	Fertilizer Plt.	.....	.....	Under Constr.	1950	.....	Owner	.....
McMurray Refining Co.	Tyler, Texas	Fluid Cat Cracker, Gas-Conc., Feed Prep. & Cycle-Oil Crk.	5,000 bbls.	.....	Planned	Fall, 1950	.....	U.O.P.	U.O.P.
North American Oil Consolidated & Ungren & Fraser.	Bartlett Field, Jones County,	Gaso. Plt., Gas Injection Facilities.	.....	.....	Planning	.....	.....	.....	.....
Phillips Pet.	Phillips, Texas	Cat. Cracker	30,000 bbls.	.....	Planning	Sept., 1950	.....	.....	Braun
Pontiac Refining Co. & Chicago Corp.	Corpus Christi, Texas	Ref. Petro-chem. Plt.	5,000 bbls. gaso., 170,000 bbls. ethylene glycol, 3,000 lbs. ethylene	$15 million	Design, Planning	Mid., 1951	.....	.....	.....
The Pure Oil Co.	Dollarhide, Andrews Co., Tex	Nat. Gaso. Plt.	22,000 mcf	$6 million	Under Constr.	July, 1950	.....	.....	Hudson
Shamrock Oil & Gas Co.	Sunray, Texas	Houdri. Cat. Crk.	5,000 bbls.	.....	Under Constr.	Early 1951	Houdry	.....	Cat. Constr. (Philadelphia)
Standard Oil Co. of Texas	7 mi. N. Snyder, Scurry Co., Tex.	Gaso. Absorp. Plt.	20,000 mcf	$1.5 million	Under Constr.	Aug., 1950	.....	Staff	Staff
*Standard (Texas)	Cedar Point, Texas	Compressor Instln.	.....	.....	Under Constr.	July, 1950	.....	Staff	Pioneer
Stanolind O&G	Brownsville, Tex.	Chemical Plant	150 tons	.....	Under Constr.	July, 1950	.....	Badger	Badger
Superior Oil Co.	Altair Field, Colo. Co., Tex.	Gaso. Plt.	50,000—70,000 mcf. gas	$1.5 million	Planning	.....	.....	.....	.....
United Gas Pipe Line	Sterlington, La.	Dehydration	†25,000 mcf	.....	Under Constr.	.....	.....	.....	Staff

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
ROCKY MOUNTAIN									
Frontier Refining Co.	Cheyenne, Wyo.	2 Coke Crks.	3,500 bbls.	$725,000	Under Constr.	Aug., 1950	U.O.P.	Ref. Eng.	Ref. Eng.
Pan-Am Southern	El Dorado, Ark.	Cat. Crk., Vap. Recov.	9,000 bbls.		Contracted	April, 1951			Foster Wheeler
Pan-Am.	El Dorado, Ark.	Coking unit			Under Constr.	Sept., 1950		Lummus	Foster Wheeler
Salt Lake Refining Co.	Salt Lake City	Cat. Cracking	25,000 bbls.	$10 million	Authorized	Jan., 1951	Houdry	Bechtel-Houdry	Bechtel
Sioux Oil Co.	Newcastle, Wyo.	Thermal Crk.	1,200 bbls.	$300,000	Under Constr.	July, 1950	U.O.P.	Koch	Staff
Sioux Oil Co.	Newcastle, Wyo	Cat. Poly.	60 bbls.	$100,000	Under Constr.	July, 1950	U.O.P.	Koch	Staff
WEST COAST									
Continental Oil Co.	Ventura, Calif.	Rev. to Gaso. Plt.	23,000 mcf		Under Constr.	July, 1950		Ref. Maint.	E. & A. Ref.Maint.
General Petroleum	Torrance, Calif.	Compr. & Heater			Completed			Ref. Maint.	Ref. Maint
General Petroleum	Torrance, Calif.	Add Odor Abate. System		$80,000	Completed			Staff	Staff
General Petroleum	Torrance, Calif.	Dust Collecting Sys. to Gaso. Cat. Crk.		$25,000	Completed			Staff, Ref. Maint.	Ref. Maint.
General Petroleum	Torrance, Calif.	Smoke, Fume, Odor Contrls.		$250,000	Completed			Staff	
General Petroleum	Torrance, Calif.	Cat. Crk., Fur.	4,000 bbls.		Completed				Lummus
Hancock Oil Co.	Long Beach	Ethylene Glycol	60,000 lbs.		Considering			Badger	Badger
Paloma Refining Co.	Paloma Field, Calif.	Ext. Almp. Sect.	60,000 mcf	$4.2 million	Completed			Braun	Braun
Richfield Oil Corp.	So. Cuyama, Calif.	Almp. & Comp. Plt.	30,000 mcf		Completed			Fluor	Fluor
Stanacal Asphalt & Bitumuls Co.	Point Wells, Wash.	Asphalt Refinery			Under Constr.	3rd Qtr., 1950			
Standard Oil (Calif.)	Richmond, Calif.	Vac. Tower	55,000 bbls.		Approved	May, 1951	Houdry	Staff	Bechtel
		TCC to Houdry	45,000 bbls.		Engineering	May, 1951			
Union Oil Co. of Calif.	Brea Olinda, Cal.	Research Plant		$5 million	Projected	July, 1951		Austin, Field and Fry	Walker
Union Oil of Calif.	Oleum, Calif.	Revise Refg.		$4 million	Completed			Parsons, E. & A.	Ref. Maint.
Union Oil of Calif.	Oleum, Calif.	Improve Handling Facilities		$1.5 million	Completed			Mathews, Montgomery	Early, C. N. Peterson, Mathews
Union Oil of Calif.	Oleum, Calif.	Tankage and Utilities		$1.8 million	Completed			Parsons	Eaton & Smith, C.B.&I., Utah
Union Oil of Calif.	Oleum, Calif.	Add Main Office Shops		$1 million	Completed			Austin, Field & Fry, D. R. Warren Co., Montgomery	E. S. McKittrick, Parker, Steffens & Pearce
Union Oil of Calif.	Oleum, Calif.	Add Ref. Faclts.			Completed				
FOREIGN									
Canada									
British-American Oil Co.	Edmonton, Alberta	Refinery	5,500 bbls.		Under Constr.	Early, 1951		Can. Kellogg	Can. Kellogg
British-American Oil	Clarkson, Ontario, Can.	Propane Deasphalt.	700 bbls.	$400,000	Completed		S.O.D., Union Oil (Calif.), Standard (Ind.)	Canadian Kellogg	Canadian Kellogg
Excelsior Refs., Ltd.	Lloydminster, Alberta	Capacity Inc.	3,000 bbls.		Under Constr.	1950			
Excelsior Refs., Ltd.	Lloydminster	Capacity Inc.	1,500 bbls.		Design	1950			
Imperial Oil, Ltd.	Leduc Field	Gas Absorption	24,000 mcf	$6.5 million	Completed			Braun	Braun
Imperial Oil	Winnipeg	New Refinery	10,000 bbls.	$10 million	Engineering	May, 1951		Canadian Kellogg	Canadian Kellogg
McColl Frontenac Oil Co., Ltd.	Edmonton, Alta	Crd. Processing Cat. Crk.	5,500 bbls.	$10 million	Contracted	1951		Foster Wheeler	Foster Wheeler
Panther Oil and Grease Co.	Leaside, Toronto, Ontario	Grease and Compounding			Projected				
Shell Oil Co. of Canada, Ltd.	Montreal East, Quebec	Fluid Cat. Crk., Vac. Flash Gas Recov., Poly, Treat	35,000 bbls.		Under Constr.	Oct., 1950		Staff	Fluor, Ltd., McKee
Supreme Refineries, Ltd.	Hanna, Alt.	Nat. Gaso. Plt.	1,000 mcf.	$100,000	Under Constr.	Summer, 1950		Staff	Staff
Supreme Refineries	Ogden, Alt.	Refinery	1,000 bbls.	$100,000	Under Constr.	Summer, 1950		Staff	Staff
Latin America									
Administracion Nacional Combustible Alcohol y Portland	Montevideo, Uruguay	Lube, Asphalt Units	7,500 bbls.		Under Constr.	Summer, 1950		Foster Wheeler	Staff
Conselho Nacional do Petroleo	Mataripe, Bahia, Brazil	Thermal Cracking Refinery	2,500 bbls.	$5 million	Under Constr.	Dec., 1950		Kellogg	Kellogg, Staff
Conselho Nacional do Petroleo	Cubatao Sao Paulo, Brazil	Therm. Crk. Ref.	45,000 bbls.		Designing			Hydrocarbon	Fives-Lille & Schneider, Staff
Conselho Nacional do Petroleo	Mataripe, Bahia, Brazil	Ref. Expn.	2,500 bbls.	$3.5 million	Planning	Dec., 1950			
Creole Pet. Corp.	El Roble Field, Venezuela	Repressuring			Planning				
Ipiranga S.A. Cia Brasileira de Petroleos	Rio Grande, Brazil	Therm. Crk. Ref.	2,000 bbls.		Authorized	1952	Foster Wheeler		
Venezuelan Gulf Refining Co.	Puerto la Cruz, Venezuela	Refinery	30,000 bbls.		Completed				
Petroleos Mexicanos	Poza Rica, Mex.	Gas Purification Pressure Maint.		$13 million	Under Constr.	Dec., 1950		McKee	McKee
Petroleos Mexicanos	Salamanca, Mex.	Crd., Gasol. Crk.	25,000 bbls.	$12 million	Under Constr.	Aug., 1950	U.O.P.	McKee	McKee
Petroleos Mexicanos	Reynosa, Mex.	Refinery	4,000 bbls	$1 million	Under Constr.	Jan., 1951		Staff	Staff
Phillips Oil Co.	San Roque Fld., Anzoategui, Ven.	Refinery, Wax Plt.	2 mln lbs. wax/ year		Planning	1952			
Puerto Rican Oil Refining Co.	Near Ponce, Puerto Rico	Refinery	25,000 bbls.	$20 million	Projected	1st Qtr., 1951	Undetermined	Parsons, Brinckerhoff, Hall and Macdonald	
Refinaria de Petroleos do Distrito Federal S.A.	Rio de Janeiro, D. F. Brazil	Therm. Crk.	10,000 bbls.		Authorized				Fives, Lille, Schneider, Staff Foster Wheeler
Refinaria e Exploracao de Petroleo Uniao S.A.	Capuava, Sao Paulo, Brazil	Therm. Crk. Ref.	20,000 bbls.		Authorized			P. A. Hydro. Res.	Czech. Fact. Metal Work Mech. Constr.
Richmond Exploration Co.	Bajo Grande, Venezuela	New Refinery	35,000 bbls.		Deferred				
Shell Caribbean Pet. Co.	La Paz, Venezuela	Gas Plant	60 tons		Under Constr.	Summer, 1950			

CONTINUED ON PAGE 77

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Abstract: *Experimental work is described on testing of various steels and alloys for corrosion resistance in gas-treating solutions employing monoethanolamine. A theory of such corrosion is developed. Apparatus and methods are detailed, and data are presented in tables and graphs.*

2f **"Chemical Deterioration of Cooling Tower Lumber"**

By: CLYDE L. BLOHM, *Assistant Director of Research, and* HENRY D. FRASIER, *Research Chemical Engineer*

Abstract: *So-called "delignification" of cooling tower lumber is discussed, augmented by field observations and experimental data.*

3f **"Effect of Pulsation on Gas Measurement"**

By: C. F. YATES, *Research Engineer*

Abstract: *This paper discusses the effect of pulsative flow on the accuracy of measuring gas-flow rate by orifice meters. Data are presented showing the relationship between magnitude and nature of the pulse and the resultant readings recorded by the measuring instrument.*

4f **"Fractionating Absorbers in the Petroleum Industry"**

By: J. C. HANNAH, *Process Engineer*

Abstract: *Rapidly changing conditions necessitate familiarity with all methods now in use in the petroleum industry for separating mixtures of low-boiling hydrocarbons and associated compounds in order to obtain the most economic method for a given gas recovery and/or purification problem. This paper discusses one of these methods, i.e., fractionating absorbers. An example of application to actual plant data is shown.*

5f **"Mechanical Vibration of Piping Induced by Gas-Pressure Pulsations"**

By: R. C. BAIRD, *Research Engineer, and* I. C. BECHTOLD, *Director of Research and Development*

Abstract: *The generation and nature of gas-pressure pulses from reciprocating compressor action are described, together with the propagation of such pulses through pipe lines. The means whereby pulse energy is converted to mechanical vibration is discussed by the aid of analogous mechanical, acoustical, and electrical oscillatory systems. The economic importance of minimizing vibration in compressor and compressor-dependent installations is indicated.*

6f **"A Critical Analysis of Methods of Determination of Water Dew Point in Hydrocarbon Gases"**

By: F. C. RIESENFELD, *Research Chemist, and* H. D. FRASIER, *Research Chemical Engineer*

Abstract: *The authors have found that the values obtained from conventional dew point determination apparatus do not give true results when used on gases effluent from liquid dehydrators. A theoretical explanation for this phenomenon and a description of a method for determining the absolute water content of gases from this type of dehydrator is offered.*

7f **"Purification and Dehydration of Gases"**

By: C. L. BLOHM, *Assistant Director of Research, and* W. F. CHAPIN, *Process Engineer*

Abstract: *This paper covers the chemistry and chemical engineering of regenerative processes for removing hydrogen sulfide and carbon dioxide from gases by use of amine processes together with their simultaneous or subsequent dehydration. In addition there is presented a description of the engineering features and operation of the Glycol-Amine plants which treat gas transported through the Texas-California line.*

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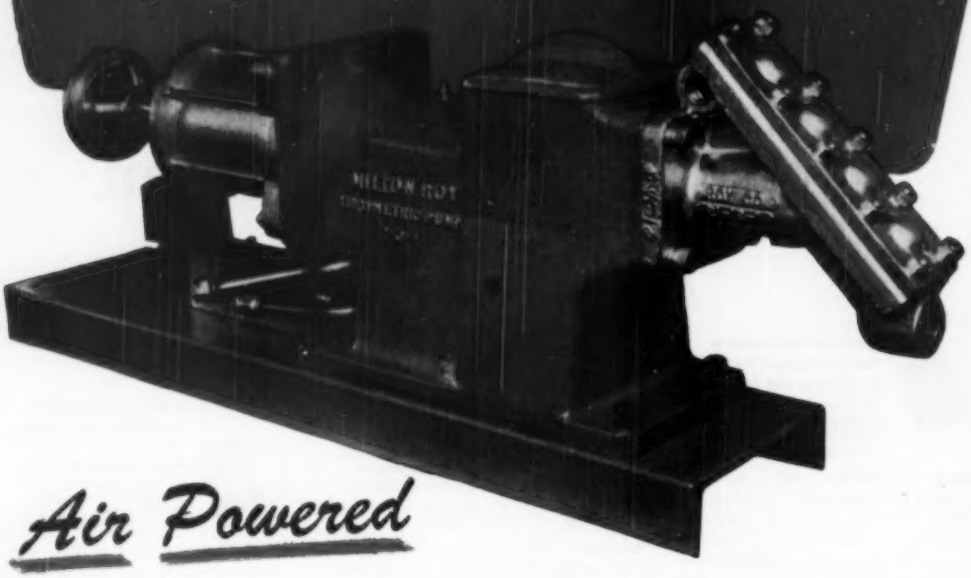

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COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Shell Caribbean Pet.	Mara, Ven.	Gas Plant	90 tons		Projected	Early 1951			
Venezuelan Pet. Co.	Puerto la Cruz, Venezuela	Refinery	35,000 bbls.		Under Constr.			Snare	Snare
Yacimientos Petroliferos Fiscales	Buenos Aires, Argentina	New Refinery	28,000 bbls.	$54 million	Design	1951		Kellogg	Kellogg
YPF	La Plata, Argentina	Crude Topping, Gas Treating	50,000 bbls.	$2.8 million	Under Constr.	Summer, 1950		Houdry Process Cat. Constr.	Cat. Constr.
YPF Bolivianos	Cochabamba, Bolivia	Topping & Reforming Units	5,000 bbls.		Under Constr.	3rd Qtr., 1950		Foster Wheeler	Foster Wheeler
Europe and Africa									
Anglo-American Oil	Fawley, Eng.	Refinery	110,000 bbls.	$150 million	Under Constr	Late 1951		Foster Wheeler	Foster Wheeler
Anglo-American	Fawley, Eng.	SO_2 Extraction	12,000 bbls.		Design			Badger	Badger
Anglo-American	Fawley, Eng.	Fluid Cat. Crk.	1 million gals.		Under Constr.				
Anglo-Iranian Oil	Isle of Grain, Eng.	Cont. Refg. Unit	60,000 bbls.	$120 million	Planning	1953			
Anglo-Transvaal Consolidated Investment Co.	Vall River, Union of South Africa	Synthetic Gasoline and Diesel Oil Plant		$50-60 million	Contracted			Hydro. Res.	
Aquila, S.A.	Trieste, Italy	Lube Oil Ref.	800 bbls	$7.9 million	Design	Mar., 1951	Juik, Texaco	Badger	Badger
Azienda Generale Italiana Petroli	Rome, Italy	Add to Plant	24,000 bbls.		Projected	Late 1951			
Azienda Generale Italiana Petroli	Palermo, Italy	Marine Fuel Plant	7,800 bbls.						
My. Bataafsche Pet.	Pernis, Holland	Expansion	80,000 bbls.		Under Constr.	Mid 1952		Stone & Webster	Stone & Webster
British Petroleum Chem.	Grangemouth, Scotland	Petrochem			Under Constr.	Dec., 1950			
Cabot Carbon, Ltd. (Geoffrey L. Cabot, Inc.)	Ellesmere Port, Eng.	Carbon Black Plant	50,000 lbs./yr.		Under Constr.	1950		Simon-Carves, Ltd.	Simon-Carves, Ltd.
Cie. de Raffinage Shell-Berre	Berre, France	Expansion	30,000 bbls.	$31.6 million	Under Constr.	Mid., 1951			
Shell	Petit-Couronne	Teepol Plant	23,000 tons/yr.		Under Constr.	1st Qtr., 1951			
Cie. de Raffinage Shell-Berre	Petit Couronne, France	Lube Unit			Planned				
Cie. de Raffinage Shell-Berre	Petit-Couronne (Rouen), France	Expansion	10,000 bbls.		Completed				
Cie. Francaise de Raffinage	Gonfreville, France	Therm. Reform., Prop. Deasp., Furfl. Trtng.	4,750 bbls.		Design	1951	Texaco & Juik	Kellogg	Local
Cie. Francaise de Raffinage	Gonfreville, France	Lube Unit	2,500 bbls.		Design	1951	Texaco	Kellogg-Lummus	
Cie. Francaise de Raffinage	Gonfreville, France	Distillation Unit	20,000 bbls.		Under Constr.	3rd Qtr., 1950		Foster Wheeler	Foster Wheeler
Cie Francaise de Raffinage	Provence, France	Topping Unit	20,000 bbls.		Under Constr.	4th Qtr., 1950		Foster Wheeler	Foster Wheeler
Cia Espanola de Petroleos, S.A.	Sta. Cruz de Tenerife, Canary Islands	Propane-Butane Fractionating.	204 bbls.	$100,000	Under Constr.	Late 1950		U.O.P.	U.O.P.
C.E.P.S.A.	Canary Islands	Propane-Deas.	702 bbls	$300,000	Under Constr.	Late 1950	Standard Oil	Foster Wheeler	Foster Wheeler
Condor, S.P.A. Per l Industriale Pet. Chemica	Rho, Italy	New Refinery	1.5 mln tons/yr		Under Constr.				
Danish Government	Denmark	Refinery	21,000 bbls.		Planned			Lummus	Lummus
Egyptian Government	Cairo, Egypt	Crude Plant							
Industrie Chimiche Italiane Petroli	Mantua, Italy	Crude	4,500 bbls.						
Industria Nazionlane Petroli e Trasformaziche	Massa Carrara, Italy	Refinery	40,000 bbls.			Late 1951			
Industria Petrolifera e Chimica	Milan, Italy	Gasoline Fuel Oil Plant	20,000 bbls.					Dr. Calogero Inglogio	
Imperial Chemical Industries, Ltd.	Wilton, Yorkshire, England	Petroleum Cracking Unit			Under Constr.	End 1950		Kellogg	Kellogg
L'Allinare Petrofina.	Antwerp, Belg.	Refinery	21,000 bbls.		Planned				
Manchester Oil Refinery, Ltd.	Partington, England	Cat. Crk., Lube Reforming	20,000 bbls.		Projected				
Monsanto Chemical Co.	Britain	Add Polystyrene			Under Constr.	July, 1951		Staff	Staff
National Oil Refineries	Llandarcy, Wales	Furf. Ref. Sol. Dewax, Wax Fractn.	1,200 bbls.	$36 million	Designing	Early 1953	Texaco	Badger	Badger
National Oil Refineries	Llandarcy, Wales	SO_2 Solvent Extraction	9,000 bbls.		Contracted	Early 1951		H.W.P.	H.W.P.
Pechelbronn, S. A. E. M.	Merkwiller, France	Capacity Increase	1,550 bbls.		Authorized	1950			
Petrocarbon, Ltd.	Partington, England	Cat. Cracker, Lube & Reform	20,000 bbls.						
Petro Chem., Ltd.	Partington, England	Petrochemicals	2,000 bbls.	$16 million	Under Constr.	3rd Qtr., 1950	Petro-Carbon	Petro-Carbon	Petro-Carbon
Philblack, Ltd.	Avonmouth, England	Carbon Blk. Pl	137,000 bbls.	$5 million	Contracted	Aug., 1950	Phillips	H.W.P.	H.W.P.
Ref. de Pet. de Escom. S.A.	Escombreras, Spain	Add Refinery	20,000 bbls.		Under Constr.	Oct. 1, 1951			
*Raff. Belge de Petroleos, S.A.	Antwerp, Belg.	Topping Unit	7,000 bbls.		Planning	Summer, 1951			
Raffinerie Belge	Antwerp, Bel.	Atmos., Vac. Distill.	7,000 bbls.	$1.5 million	Planning	June, 1951			
Raffinerie Belge	Antwerp, Belg.	Therm. Crk., Reform., Gas Plant	7,000 bbls.	$2 million	Under Constr.	July, 1950		Barnes	Barnes
Raffineries Francaises de Petrole de l'Atlantique	St. Nazaire, France	Consolidate Refineries	7,100 bbls.	$9.4 million					
Raffinerie Siciliane Oli Minerali, Sp.A.	Augusta, Sicily	Crude Refinery	10,000 bbls.		Under Constr.	July, 1950	U.O.P.	U.O.P., Delta, Staff	Staff
Scottish Oils, Ltd.	Grangemouth, Scotland	Stage I: 1 Pipe Still Distill., Steam Boil. & Power Plt.	1.5 mln. tons per yr. 20,000 kw.		Under Constr.	End 1950		Kellogg	Kellogg
Scottish Oils	Grangemouth, Scotland	Stage II: Cat. Crk., Vac. Distill., Cat. Poly Plt., & Trtng Plt.			Planned	Mid., 1952			
Scottish Oils, Ltd.	Grangemouth, Scot.	Buoyancy Foundations			Under Constr.	End 1950		Rendel Palmer and Tritton	
Shell Chemical Mfg. Co., Ltd.	Thornton, Eng.	Teepol Plant Extension	75,000 tons per year		Under Constr.	Summer, 1950			
Shell Refining & Marketing Co., Ltd.	Stanlow, Eng.	Comprehensive Refining	60,000 bbls.		Under Constr.	Early 1952			

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Shell Refining & Marketing Co., Ltd.	Shell Haven, England	Comprehensive Refining	40,000 bbls.	$36 million	Under Constr.	Mid 1953	.....	.....	.....
Societe Generale des Huiles de Petrole	Lavera, France	LPG Units	25,000 bbls.	.....	Completed	.....	Kellogg	Kellogg	Staff
Societe Generale.....	Dunkirk, France	Crude Reform.	33,000 bbls.	.....	Under Constr.	Mid 1951	Lummus, Kellogg	Lummus, Kellogg	Lummus, Kellogg
Societe Generale.....	Dunkirk, France	Furf. Ref. Sol. Dewax., Wax Fractn.	2,400 bbls	.....	Under Constr.	Mid 1951	Texaco	Lummus	Lummus
Societe Industrial Belge des Petroles	Antwerp, Belgium	Crd. Crk. Ref.	30,000 bbls.	.....	Under Constr.	Mid 1951	.....	Kellogg	Kellogg
Societe Raffinazione Oli Minerali (IROM)	Porto Marghera, Italy	Atmospheric & Vac. Distill., Acid Treat., Contract Filtration for Lube Oils, Electric Gen. Unit, Load. Facilities	11,000 bbls.	$6.4 million	Contracted	.....	.....	H.W.P.	H.W.P.
Societe per Azioni Raffineria Padana Oli Minerali	San Martino di Trecate, Italy	Refinery	12,000 bbls.	.....	Proposed	.....	.....	.....	.....
Socony-Vacuum Francaise	Notre Dame de Gravenchon	MEK Unit	1,000 bbls.	.....	Under Constr.	Fall, 1950	Texaco	Lummus	Staff
Socony-Vacuum Francaise	Notre Dame de Gravenchon	Propane Deasphalting	1,100 bbls.	.....	Under Constr.	Summer, 1950	Juik	Lummus	Staff
Socony-Vacuum Francaise	Notre Dame de Gravenchon	Grease and Compounding	900 lbs.	.....	Under Constr.	Winter, 1950	.....	Staff	Staff
Socony-Vacuum Italiana, S.p.A.	Naples, Italy	Visbreaker	.....	.....	.....	Fall, 1950	.....	Staff	Staff
Socony-Vacuum Italiana, S.p.A.	Naples, Italy	Topping Unit	15,000 bbls.	.....	Under Constr.	Fall, 1950	.....	Staff	Staff
Stand.-Azienda Gen. Indro. Comb. (Stanic)	Leghorn, It.	Add Capacity	21,000 bbls.	.....	.....	.....	.....	.....	.....
Ditto (Stanic).....	Bari, Italy	Add Capacity	12,000 bbls.	.....	.....	.....	.....	.....	.....
Standard Francaise des Petroles	Port Jerome, France	Dewaxing Plant	1,300 bbls.	$6.4 million	Design	Late 1951	.....	S.O.D.	Foster Wheeler
Standard Francaise des Petroles	Port Jerome, France	Desophalting Plant	1,500 bbls.		Design	Late 1951	.....	S.O.D.	.....
Standard Oil Co., (N.J.)	Belgium	Dist. Crack.	33,000 bbls.	.....	Planned	Early 1952	.....	.....	.....
Trent Oil Prod. Development Co.	North Shields, England	Crude Plant	11,500 bbls.	$4.8 million	Plans approved	.....	.....	.....	.....
Union Petrol Refinery, Ltd.	Johannesburg, Union of South Africa	New Refinery	.....	$20 million	Projected	.....	.....	.....	.....
Vacuum Oil Co., Ltd.	Coryton, Eng.	Lube Refinery	20,000 bbls.	$30 million	Planned	Sept., 1952	.....	.....	.....
Near East									
Anglo-Iranian Oil.....	Abadan, Iran	Gas Plant	25,000 mcf	$2 million	Under Constr.	1950	.....	Badger	Badger
Anglo-Iranian.....	Abadan, Iran	Cat. Cracker	30,000 bbls.	.....	Under Constr.	1951	.....	Foster Wheeler	Foster Wheeler
Anglo-Iranian.....	Abadan, Iran	Solvent Dewax.	700 bbls.	.....	Under Constr.	4th Qtr., 1950	Texaco	Badger	Badger
Anglo-Iranian.....	Abadan, Iran	Gas Recov., Stab.	22,000 mcf	.....	Under Constr.	Mar., 1951	.....	Badger	Badger
Arabian American Oil Co.	Abqaiq, Saudi Arabia	Crude Oil Stabilizer	300,000 bbls.	$4.8 million	Under Constr.	Dec., 1950	.....	Staff and Fluor	Fluor
Arabian American ...	Ras Tanura, S.A.	Asphalt Plant	500 bbls.	$1.25 million	Under Constr.	1950	.....	Staff, Bechtel	Staff
Bahrein Pet. Co., Ltd.	Bahrein Island	Crd. Still Util.	55,000 bbls.	$9.1 million	Under Constr.	Aug., 1950	.....	Lummus, Bechtel	Int. Bechtel, Inc.
Consolidated Ref., Ltd.	Haifa, Palestine	Crude Plant	80,000 bbls.	.....	Planned	Late, 1951	.....	Badger	Badger
Consolidated Ref., Ltd.	Haifa, Palestine	Gas. Facilities	.....	.....	Under Design	.....	.....	Badger	.....
Consolidated Ref., Ltd.	Haifa, Palestine	Lube Plant	2,500 bbls.	.....	Designing	.....	Texaco, Juik	Lummus, Kellogg	Lummus, Kellogg
Far East									
Batasfsche Pet. Mij. (Shell)	Balikpapan, Borneo, East Indies	Expansion	42,000 bbls	.....	Under Constr.	Mid 1952	.....	.....	.....
Batasfsche Pet. Mij.	Pladjoe, Sumatra	Rehab. to Comprehensive Refg.	70,000 bbls.	.....	Under Constr.	Mid 1951	.....	.....	.....
Burmah Oil Co., Ltd.	Syriam, Burma	Furf., Sol. Dewax., Wax Mfg	1,000 bbls.	$600,000	Designing	.....	Texaco	Badger	.....
Burmah Oil Co.....	Syriam, Burma	Thermafor Clay Revivification	66 tons	$150,000	Engineered	1950	Max Miller, Socony-Vacuum	Max Miller	.....
Pacific Refineries, Ltd.	Honolulu, Hawaii	Butane, Asph., Gas Oil, Lt., Fretns. Refg.	3,000 bbls.	$1.5 million	Under Constr.	Late Summer, 1950	.....	Fish Eng	Fish Eng
Toa Nenryo Kogyo, Ltd.	Wakayama, Japan	Cracking	3,500 bbls.	.....	Designing	Fall, 1950	.....	.....	Staff
Oceania									
Australian Shell Oil Co.	Clyde, New S. W., Australia	Lubsol Refining	250 bbls.	.....	Under Constr.	Late 1950	.....	.....	.....
Australian Shell Oil Co.	Geelong, Victoria, Australia	New Refinery	.....	$4.8 million	Under Constr.	Late 1951	.....	.....	.....
Australian Shell Oil Co.	Geelong, Victoria, Australia	Bitumen and Lubsol Plant	.....	.....	Projected	.....	.....	.....	.....
Australian Shell Oil Co.	Geelong, Victoria, Australia	Asphalt, Lube Sol. Extct Plt.	.....	.....	.....	.....	.....	.....	.....

* First appearance in tabulation. † Added capacity.

NOTE: Austin—Austin Co. Badger—E. B. Badger & Sons. Barnes—W. M. Barnes & Co. Bechtel—Bechtel Corp. Bellows—W. S. Bellows Co. Blaw-Knox—Blaw-Knox Construction Co. Bowden—W. H. Bowden. Braun—C. F. Braun Co. Brown Eng.—Brown Engineering Co. Brown & Lite—Brown & Lite Co. Brown & Root—Brown & Root Construction Co. Can. Kellogg—Canadian Kellogg Co. Cat. Constr.—Catalytic Construction Co. Chemico—Chemical Construction Co. C.B.&I.—Chicago Bridge & Iron Works Co. Clarke—Clarke Construction Co. Constr. Service—Construction Service Co. Delta—Delta Engineering Corp. Dresser—Dresser Engineering Corp. E.&A.—Ebrhart & Arthur, Inc. Ferguson—H. K. Ferguson. Fish Eng.—Fish Engineering Corp. Fluor—Fluor Corp. Foster Wheeler—Foster Wheeler Corp. Gasc. Plant—Gasoline Plant Construction Co. General American—General American Transportation Co. Girdler—The Girdler Corp. Graff—Graff Engineering & Equipment Co. Graver—Graver Construction Co., Inc. Grebe & Doremus—Grebe & Doremus Process Co. Hammond—Hammond Iron Works. Harris—John W. Harris Associate, Inc. Houdry—Houdry Corp. Hudson—Hudson Engineering Corp. H.W.P.—Head Wrightson Process, Ltd. Hydro Res.—Hydrocarbon Research, Inc. Ind. Eng.—Industrial Engineers, Inc. J.&L. Constr.—Construction Division, Jones & Laughlin Supply Co. Kellogg—M. W. Kellogg Co. Koch—Koch Engineering Co. Koppers—Koppers Co., Inc. Knowles—Morris Knowles & Co. Knutson—Knutson Construction Co. Leonard—Leonard Construction Co. Lummus—The Lummus Co. Mahoney—Mahoney Contracting Co. Mason—Mason Brothers Construction Co. Mathews—Mathews Conveyor Co. McKee—Arthur G. McKee Co. Max Miller—Max B. Miller & Co. Michael-Poling—Michael-Poling Construction Co., Inc. Montgomery—J. M. Montgomery & Co. P. A. Hydro Res.—Pan American Hydrocarbon Research, Inc. Parsons—The Ralph M. Parsons Co. Perco—Division Phillips Petroleum Co. Pet. Eng.—Petroleum Engineering Inc. Petroco—Petroleum Rectifying Co. Pioneer—Pioneer Industrial Co. Pritchard—J. F. Pritchard Co. Pro. Eng.—Process Engineers, Inc. Process Constr.—Process Construction Co. Ref. Eng.—Refinery Engineering Co. Ref. Maint.—Refinery Maintenance Co., Inc. Rust Eng.—Rust Engineering Co. Rust Pro.—Rust Process Design Co. Schneider—Schneider & Cie. Snare—Frederick Snare Corp. Sollitt—Summer S. Sollitt Co. S.O.D.—Standard Oil Development Co. State Eng.—State Engineering Co. Stearns-Roger—Stearns-Roger Manufacturing Co. Stone & Webster—Stone & Webster Construction Co. Telleposen—Telleposen Construction Co. Texaco—Texaco Development Co. U.O.P.—Universal Oil Products Co. Utah—Utah Construction Co. Voorhees, Walker, Foley & Smith. Walker—P. J. Walker Co. Waleo—Waleo Engineering. West—F. S. West Construction Co. White—J. H. White Corp. Eng. Wohlfeld—Wohlfeld Construction Co. Equally owned California-Texas Corp. and Socony-Vacuum Oil Co., Inc

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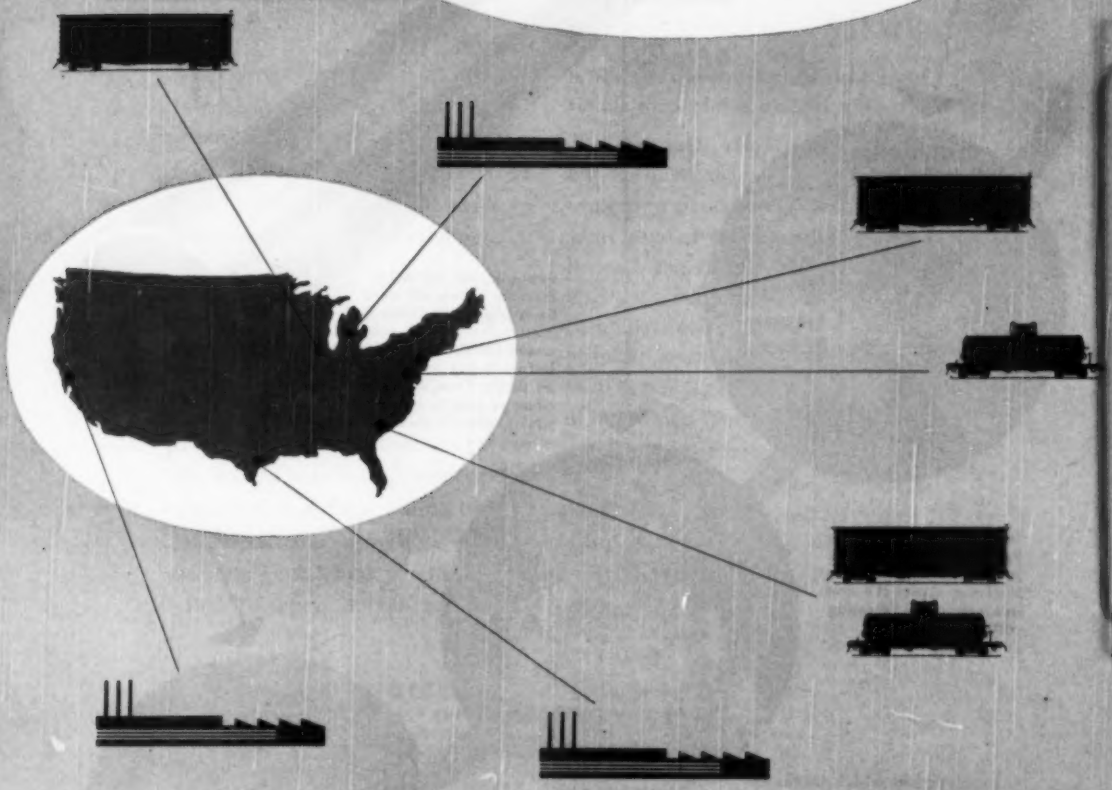

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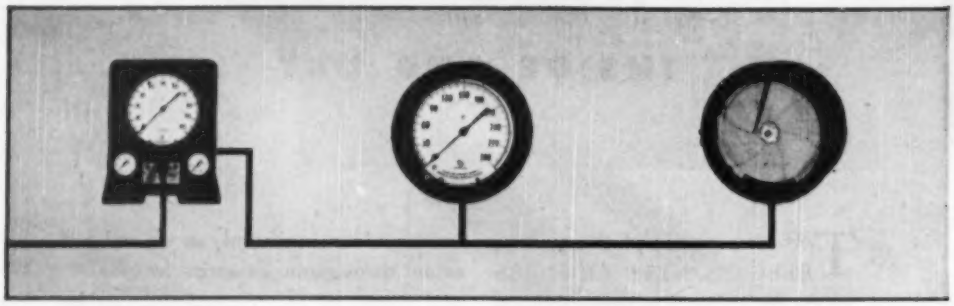

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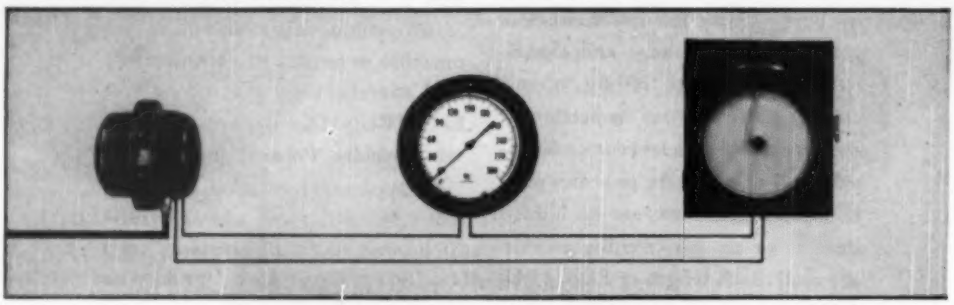

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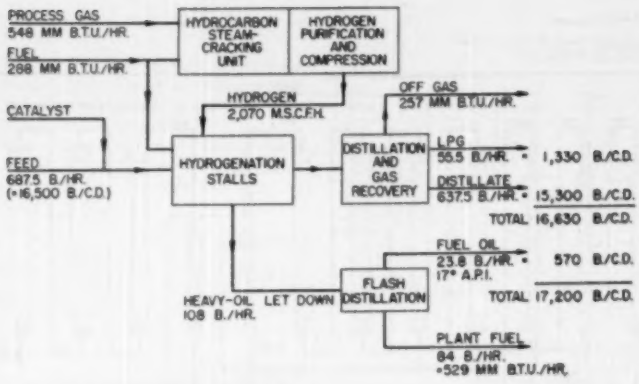

NOTE: HOURLY QUANTITIES ON CALENDAR DAY BASIS. FOR ACTUAL QUANTITIES USE 0.9 S.F.

UTILITIES REQUIREMENT:
POWER 29,000 KW.
STEAM 135,000 LB./HR.

Figure 1. Material Balance Flow Diagram for 16,500-Barrel-per-Calendar Day Residual-Oil Hydrogenation Plant

Residual-Oil Hydrogenation

L. C. SKINNER, E. E. DONATH, H. SCHAPPERT and E. FRESE

***WITH APPLICATION** of new developments and the use of large units the hydrogenation process appears economical for the conversion of heavy residual oils to distillate fuels in some areas. Commercial and pilot plant experience indicates that, on a calendar day basis, 17,200 barrels of distillate products can be produced from 16,500 barrels of residuum feed stock. Fifty cetane number diesel fuel and motor grade gasoline are the main products. They are characterized as essentially saturated, low in sulfur and nitrogen regardless of the feed material.*

Estimated plant costs are $1800 to $2000 per daily barrel of product.

A pay-out time of 4 to 6 years in the Midwestern and California areas and of 5 to 8 years in the Atlantic Coast area is calculated at market prices of June, 1949.

Mr. Skinner is chemical engineer, coal-to-oil demonstration branch, Office of Synthetic Liquid Fuels, Bureau of Mines, Louisiana, Mo. Present address of Messrs. Donath, Schappert and Frese is Koppers Company, Inc., Pittsburgh 19.

RESIDUAL oils are now burdensome to refiners. According to published statements[1] of petroleum-industry representatives, such residual oils will be in ample supply for many years.

Hydrogenation offers a possibility for the conversion of such fuels into distillate oils and gasoline. Residual oils usually have a high content of sulfur and nitrogen, which are removed by the hydrogenation process. The processing of residual oils from sour crudes poses no special problems.

A recent publication[2] contains plant and operating costs for producing gasoline by coal hydrogenation. Equipment and plant cost data given in that report are used to estimate the cost of a residual-oil hydrogenation plant. The 10,000-psi. pressure was selected because at this pressure cracked residues, regardless of type and origin, can be processed with high thruput and yield. In many cases a lower working pressure will be more economical.

The flow sheet used in this study was based on the assumption that the refiner will convert heavy residual oil into high-quality distillates: Diesel fuel, kerosine, jet fuel, gasoline, etc., or catalytic cracking feed stock. It was also assumed that adequate cracking capacity is available in the refinery to convert the distillate fuels to gasoline if required. Therefore, complete hydrogenation to gasoline, although possible, with a high yield, is not included in this study. The hydrogenation plant is considered as an integral part of the refinery; residual oil feed, fuel gas and utilities are obtained from the refinery and hydrogenation products delivered to it. The cost of utilities production has not been included since in many areas the power can be purchased more economically, in other cases the additional investment will be governed by the capacity of existing facilities. For a specific installation this factor should be investigated to determine its effect on investment.

A cracked residue having the following properties is assumed as feed: Specific gravity, 1.02 (7° API), viscosity, above 300 SSF at 122° F. The yield of hydrogenated products is based on a total sulfur, nitrogen, and oxygen content of 4 percent in the feed. These elements are removed as H_2S, NH_3 and H_2O. Feed stocks of lower specific gravity (higher API gravity), such as straight-run residues, consume less hydrogen and could be processed with a higher throughput and lower cost.

Data for residual-oil hydrogenation in commercial plants[3] were adjusted to the production of distillate oil in a combination process using other commercial[4] and extensive pilot-plant[5] results. These data can be regarded as typical and representative although corrections may be necessary for a specific residual oil. The main differences in comparison to coal hydrogenation are lower hydrogen, power and steam consumption, higher throughputs and omission of coal-handling equipment.

Figure 1 is the flow sheet of the plant. Sixteen thousand five hundred

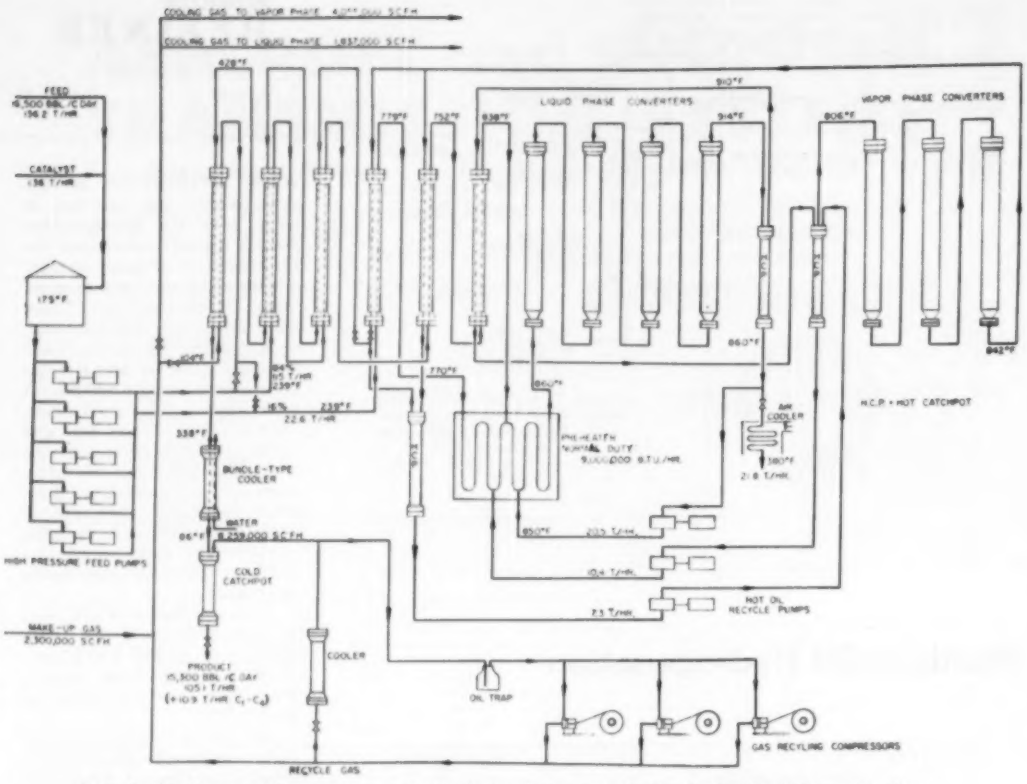

Figure 2. Flow Diagram of Stall Arrangement for 16,500 Barrels Per Calendar Day Residual-Oil Hydrogenation Plant.

barrels per calendar day are hydrogenated in a combined liquid- and vapor-phase stall. A diagram of this stall in Figure 2 shows the liquid- and vapor-phase converters in series. This permits very efficient utilization of the heat of reaction, which results in improved heat economy with the same number of heat exchangers as would be required for a liquid-phase stall. The feed with 1-percent catalyst added is preheated with recycle hydrogen in heat exchangers and a gas-fired preheater. Two parallel feed streams are used.

The feed and hydrogen react in four liquid-phase converters; 705 cubic feet reaction volume each, at a temperature of about 900° F. The products enter the first hot catchpot in which low boiling reaction products and hydrogen are removed overhead. The heavy oil, amounting to approximately 15 percent of the feed stock with the catalyst, is withdrawn from the bottom of the hot catchpot; a distillate fuel-oil fraction is flashed off and the bottoms used as plant fuel.

The oil vapors and hydrogen from the first hot catchpot are cooled in a heat exchanger to about 820° F. and enter a second hot catchpot. In this vessel the vapors are washed with hot clean oil recycled from the vapor phase to remove entrained solids in order to provide a clean feed for the vapor-phase reaction. The bottoms are recycled to the liquid-phase feed stream.

The vapor-phase catalyst, pelleted tungsten and nickel sulfide on alumina, reduces sulfur, nitrogen and oxygen compounds, saturates and splits the products, especially the higher-molecular-weight fractions. The products are cooled by heat exchange with the feed and in water coolers, then separated in the cold catchpot from the recycle gas, which returns to the system. Depressured products are processed further in conventional distillation and gas-recovery equipment.

For hydrogen production (see Figure 1) a hydrocarbon steam-cracking plant with externally fired tubular converters is provided. Natural gas, hydrogenation off gas, and refinery gas can be used as process gas. The raw hydrogen, after purification and compression, is ready for use.

The cost estimate was prepared for the hydrogenation and hydrogen production sections by making an itemized list of all major equipment. Costs for each individual item were then determined, using the aforementioned coal-hydrogenation report,[2] and totaled. From this total equipment cost the final installed cost, including all indirects as well as a 10-percent contingency and 5-percent fee, was determined by the use of factors previously established.[2] Other sections of the plant were prorated using the 0.6-power rule from existing data on several similar installations. Spare equipment, especially pumps and compressors, are included to maintain production on the basis of a 90-percent service factor. The summarized costs are given in Table 1.

The plant costs cited are based on first quarter 1948 prices. The present trend toward stabilized prices and improved labor efficiency is reported by some authors[6] to result in a slight lowering of over-all construction costs during the past two years.

Utilities requirements are listed in Table 2.

The power consumption is given in kilowatts, but to a large extent steam or gas drives, depending on local conditions, can be used.

With these data operating costs shown in Table 3 were obtained. Unit costs used for the utilities are as follow:

	Per Day
Power, 29,000 kw. at $0.008/kw.-hr.	$5,566
Steam, 135 M lb./hr. at $0.35/1,000 lb.	1,132
Water, 750 gpm. at $0.15/1,000 gal.	162
Total utilities	$6,680

Products obtained per calendar day follow:

1) 15,300 barrels per day distillates; 2) 1330 barrels per day LP-gas; and 3) 2590 barrels per day total heavy-oil letdown.

The following characteristics for the hydrogenation products from the heavy cracked residue are used:

1) Distillate

Gravity ..... 36° API
Boiling range ..... 20%—365° F.
90%—650° F.

From this distillate can be obtained:

19.3 percent = 2960 barrels per calendar day gasoline O.N. MM60. With 1.1 cc. tel. O.N. MM74.

80.7 percent = 12,340 barrels per calendar day diesel fuel, cetane number 50.

2) LP-gas

49.6 percent = 660 barrels per calendar day propane.

50.4 percent = 670 barrels per calendar day butane.

3) The total heavy-oil let-down is an oil of 1.04 specific gravity. From it 22 percent = 570 barrels per calendar day (23.8 barrels per hour) are flashed off. This fraction of specific gravity 0.95, 17° API and about 25 SSF/122° F. viscosity is utilized as fuel oil or fuel-oil blending agent. The residue, 2020 barrels per calendar day of specific gravity 1.05, which is more refractory to further hydrogenation than the feed stock, will be used as plant fuel. Two thousand and twenty barrels per day, or 84 barrels per hour, at 6.3 MM Btu. per barrel corresponds to 529 MM Btu. per hour which is sufficient to furnish the 526 MM Btu. per hour required according to Table 2.

For the hydrogen-manufacturing plant, process gas is required, An exchange of fuel oil and gas in the refinery is assumed possible. No charges are involved assuming the same cost on a Btu. basis for gaseous and liquid refinery fuel.

Table 4 shows the total products obtained from the plant which total 17,200 barrels per calendar day from 16,500 barrels feed. Average product prices based on refinery and terminal quotations[7,8] for the Midwestern, Atlantic, and California coast areas are used to obtain the realization for total products in $/calendar day. The following reduction in quoted prices for gasoline have been made to allow for tel. addition.

	Cents
82 O.N. Research	.45
83 O.N. Research	.50
74-76 O.N. MM	.30

For the feed stock two prices will be assumed, following a recommendation by a major petroleum company;[9] for the Midwestern area: 1) $1.10 per barrel, the price of 300 viscosity fuel oil and 2) $0.63 per barrel, the value of a heavy residue which when blended with 20-percent distillate oil becomes saleable 300 viscosity fuel oil.

The same formula, i.e.

$$\frac{\text{price/bbl. of No. 6 F.O.} - .2\ \text{price/bbl. of No. 2 F.O.}}{.8} = \text{price/bbl. of residue}$$

Table 1
Summary of Cost for 16,500 Barrels per Calendar Day Cracked Residue Hydrogenation Unit

	Equipment	Other Material	Labor	Indirects*	Contingency	Fee	Total
Hydrogenation	$6,466,000	$2,770,000	$1,950,000	$1,625,000	$1,285,000	$704,000	$14,800,000
Hydrogen production	4,862,000	2,010,000	1,970,000	2,084,000	1,010,000	554,000	12,490,000
Distillation and gas recovery	640,000	521,000	432,500	396,600	198,500	111,400	2,300,000
C_3—C_4 storage		(@ $36.70/bbl., total erected cost)					367,000
Feed and product storage		Available in existing plant					
Utilities distribution (elec., steam, air, gas and water incl. cooling towers)	1,310,000	520,000	742,000	670,000	324,000	177,000	3,743,000
Start-up cost	.....	.....	.....	.....	.....	.....	400,000
Total	.....	.....	.....	.....	.....	.....	36,100,000

* Includes field indirect costs, engineering, overhead and purchasing costs.

Table 2
Hourly Utilities Requirements (Stream-Day Basis)

	Kw.	Steam (Low Pressure) 1,000 Lb.	Process Gas and Fuel MM. B.t.u.	Make-Up Water g.p.m.
Hydrogenation, incl. distillation and gas recovery	8,300	78	14 (Off gas Cr.-227)	
Hydrogen production and compression	21,200	130 (Cr.-72)	828	
Cooling-water pumps and fans	900			
Miscellaneous	1,900	14		
Total, stream-day basis	32,200	150	585	835
Total, calendar-day basis	29,000	135	526	750

Table 3
Operating Costs
Hydrogenation of 16,500 Barrels per Calendar Day Cracked Residue

	$/calendar day
Total plant cost, MM$	34.1
Utilities	6,860
Catalysts	1,900
Labor (26 men per shift @ $1.75 per hr.) and 15 percent supervision	1,256
Plant maintenance—3 percent of total plant cost annually	2,802
Pay-roll overhead	390
Operating supplies	560
Indirect operating cost & overhead	2,309
Taxes & insurance (1 percent of total plant cost annually	934
Operating cost without amortization	17,011
Operating cost without amortization	17,011
(=$/B. feed)	(1.030)
(=cts./gal. feed)	(2.45)
Amortization, 15 years	6,231
Operating cost, including amortization	23,242
(=$/B. feed)	(1.410)
(=cts./gal. feed)	(3.36)

Table 4
Products and Prices

	Products, Barrels per Calendar Day	MIDWESTERN AREA Price $/Bbl.	MIDWESTERN AREA Total $/Cal. Day	ATLANTIC COAST AREA Price $/Bbl.	ATLANTIC COAST AREA Total $/Cal. Day	CALIFORNIA AREA Price $/Bbl.	CALIFORNIA AREA Total $/Cal. Day
June 22, 1949:							
Gasoline	2,960	4.08	12,077	4.71	13,942	5.25	15,540
Diesel Fuel	12,340	3.35	41,339	3.32	40,969	4.20	51,828
Propane	660	2.10	1,386	2.31	1,525	2.31	1,525
Butane	670	1.79	1,199	2.09	1,340	2.09	1,340
Fuel Oil	570	1.10	627	1.60	912	1.92	1,094
Total Products	17,200	.....	56,628	.....	58,688	.....	71,327
April 12, 1950:							
Gasoline	2,960	3.91	11,574	4.70	13,912	5.17	15,303
Diesel Fuel	12,340	3.61	44,547	3.42	42,203	3.99	49,237
Propane	660	2.40	1,580	2.40	1,580	2.40	1,580
Butane	670	2.40	1,610	2.40	1,610	2.40	1,610
Fuel Oil	570	1.50	855	1.90	1,082	1.37	780
Total Products	17,200	.....	60,166	.....	60,387	.....	68,510

Table 5
Net Increase and Pay-Out Time
Midwestern Area

		June 22, 1949		April 12, 1950	
Total plant cost, MM$		34.1	34.1	34.1	34.1
Feed at $/barrel		1.10	0.63	1.50	1.06
1) Operating cost, including amortization in 15 years	$/CD	23,242	23,242	23,242	23,242
Cost of feed material	$/CD	18,150	10,395	24,750	17,490
	$/CD	41,392	33,637	47,992	40,732
Total products	$/CD	56,628	56,628	60,160	60,160
Taxable income	$/CD	15,236	22,991	12,168	19,428
Income tax at 38 percent	$/CD	5,790	8,737	4,620	7,390
Net increase	$/CD	9,446	14,254	7,548	12,038
Net increase, cents/gas. feed		1.36	2.06	1.09	1.74
Annual net increase, percent of plant cost		10.1%	15.2%	8.1%	12.9%
2) Operating cost without amortization	$/CD	17,011	17,011	17,011	17,011
Cost of feed material	$/CD	18,150	10,395	24,750	17,490
	$/CD	35,161	27,406	41,761	34,501
Total products	$/CD	56,628	56,628	60,160	60,160
Operating margin	$/CD	21,467	29,222	18,399	25,659
Income tax at 38 percent of taxable income (see above)	$/CD	5,790	8,737	4,620	7,390
Income applicable to pay-out	$/CD	15,677	20,485	13,779	18,269
Income applicable to pay-out, cents/gallon feed		2.26	2.96	1.98	2.64
Pay-out time, years		6.0	4.6	6.8	5.1

Table 6
Net Increase and Pay-Out Time
Atlantic Coast Area

		June 22, 1949		April 12, 1950	
Total plant cost, MM$		34.1	34.1	34.1	34.1
Feed at $/barrel		1.60	1.19	1.90	1.56
1) Operating cost, including amortization in 15 years	$/CD	23,242	23,242	23,242	23,242
Cost of feed material	$/CD	26,400	19,635	31,350	25,740
	$/CD	49,642	42,877	54,592	48,982
Total products	$/CD	58,688	58,688	60,387	60,387
Taxable income	$/CD	9,046	15,811	5,795	11,405
Income tax at 38 percent	$/CD	3,437	6,008	2,200	4,340
Net increase	$/CD	5,609	9,803	3,595	7,065
Net increase, cents/gallon feed		0.81	1.42	0.52	1.02
Annual net increase, percent of plant cost		6.6%	10.4%	3.8%	7.5%
2) Operating cost without amortization	$/CD	17,011	17,011	17,011	17,011
Cost of feed material	$/CD	26,400	19,635	31,350	25,740
	$/CD	43,411	36,646	48,361	42,751
Total products	$/CD	58,688	58,688	60,387	60,387
Operating margin	$/CD	15,277	22,042	12,026	17,636
Income tax at 38 percent of taxable income (see above)	$/CD	3,437	6,008	2,200	4,340
Income applicable to pay-out	$/CD	11,840	16,034	9,826	13,296
Income applicable to pay-out, cents/gallon feed		1.71	2.32	1.42	1.92
Pay-out time, years		7.9	5.8	9.5	7.0

is used to obtain the price of the heavy residue from the quoted prices for fuel oil in the other areas.

These data for the feed stock, the operating cost from Table 3, and the realization for total products from Table 4 are used to obtain the net increase and pay-out time shown in Tables 5-7.

Using a 15-year amortization period, a net increase of 1.09-2.21 cents per gallon feed in the Midwestern and California areas and of 0.52-1.42 cents per gallon feed in the Atlantic Coast area is obtained. This corresponds to 8.1-16.3 percent and 3.8-10.4 percent respectively per year of total plant cost. An income tax rate of 38 percent[9] of the taxable income has been applied. Using the same income tax rate, a pay-out time of 4.3-6.8 years in the Midwestern and California areas and 5.8-9.5 years in the Atlantic Coast area is obtained. Figure 3 is a graph showing the approximate relationship between pay-out time and price of feed stock for various combinations of product prices.

The hydrogenation process described shows how a refinery may economically upgrade a heavy residue, for which there may be little or no demand, into quality distillates of high value and demand. At the same time no troubesome byproducts are formed. The products are stable both as to gum and color and low in sulfur and nitrogen (0.1 percent and lower) so that additional treating is not required. The products may be marketed as such or used as intermediate products within the refinery. The operation of the hydrogenation plant can be adjusted to the needs of the refinery. As an example, an excellent catalytic cracking feed stock is easily produced. On the other hand jet fuel, kerosine, and various solvent fractions could be marketed directly. Motor and aviation gasolines with high lead susceptibility could also be produced from the gas oil obtained in the liquid-phase hydrogenation of the residual fuel oil as well as from other gas oil produced in the refinery with about 100-percent volume yield in a vapor-phase hydrogenation. The off gases obtained as a byproduct in hydrogenation contain 60-percent isobutane which may be used for the production of alkylate.

The versatility of the hydrogenation process furnishes an ideal means to the refiner for meeting changing demands of oil products.

Table 7
Net Increase and Pay-Out Time
California Area

		June 22, 1949		April 12 1950	
Total plant cost, MM$		34.1	34.1	34.1	34.1
Feed at $/barrel		1.92	1.86	1.37	1.25
1) Operating cost including amortization in 15 years	$/CD	23,242	23,242	23,242	23,242
Cost of feed material	$/CD	31,680	30,690	22,605	20,625
	$/CD	54,922	53,932	45,847	43,867
Total products	$/CD	71,327	71,327	68,504	68,504
Taxable income	$/CD	16,405	17,395	22,657	24,637
Income tax at 38 percent	$/CD	6,234	6,610	8,600	9,360
Net increase	$/CD	10,171	10,785	14,057	15,277
Net increase, cents/gallon feed		1.47	1.56	2.03	2.21
Annual net increase, percent of plant cost		10.9%	11.5%	15.0%	16.3%
2) Operating cost without amortization	$/CD	17,011	17,011	17,011	17,011
Cost of feed material	$/CD	31,680	30,690	22,605	20,625
	$/CD	48,691	47,701	39,616	37,636
Total products	$/CD	71,327	71,327	68,504	68,504
Operating margin	$/CD	22,636	23,626	28,888	30,868
Income tax at 38 percent of taxable income (see above)	$/CD	6,234	6,610	8,600	9,360
Income applicable to pay-out	$/CD	16,402	17,016	20,288	21,508
Income applicable to pay-out, cents/gallon feed		2.37	2.46	2.93	3.11
Pay-out time, years		5.7	5.5	4.6	4.3

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[1] Petroleum Processing, Vol. 4, May, 1949, p. 616.

[2] Estimated Plant and Operating Cost for Producing Gasoline by Coal Hydrogenation, by L. L. Hirst, J. A. Markovits, L. C. Skinner, R. W. Dougherty, and E. E. Donath, Bureau of Mines Rep. of Investigations 4564, August, 1949.

[3] British Ministry of Fuel and Power, Report on Petroleum and Synthetic Oil Industry of Germany, London, 1947, p. 57.

[4] Work cited in footnote 3, p. 51, 54.

[5] T. O. M. Reel 75, Frames 420-478; Reel 188, Frames 130-162; Reel 202, Frames 131-144, 188-200; Reel 253, Frames 782-793.

[6] Turner Construction Co. Cost Index Heating, Piping and Air Conditioning, Vol. 22, No. 5, May, 1950, p. 70.

[7] National Petroleum News, June 22, 1949, pp. 64-66.

[8] National Petroleum News, April 12, 1950, pp. 71-77.

[9] The same company provided information on income tax allowances used in Tables 5-7. The authors gratefully acknowledge the comments of this company.

APPENDIX I

The foregoing paper has been extensively reviewed by several major oil companies. Several questions have occurred to the reviewers which will also occur to the reader. It is impractical to include the answers in the paper itself. This appendix is included to supply answers to some of these questions.

Question 1—Why was an operating pressure of 10,000 psig. selected instead of a more moderate pressure of 3000 or 4000 psig.?

Answer—Lower pressures would be adequate and more economical if straight-run residues are to be processed. The liquid-phase hydrogenation of cracked residues at these lower pressures would result in distillate oils, high in aromatic content, unsuitable for catalytic cracking feed stock or for diesel fuel. The combination of liquid- and vapor-phase hydrogenation at 10,000 psi. proposed in the paper can charge the very heavy cracked residues and produce high cetane number diesel fuels or catalytic cracking feed stocks at least equal to straight-run distillates. It was the intention of the authors to furnish data for a plant adapted initially to the hydrogenation of very refractory residues to high-quality distillates.

Question 2—The prices used for fuel oil are at the lowest level experienced in many years. A more realistic value would be to use a long-term average or relate the price of fuel oil to the cost of coal.

Answer—In some areas this method would be quite accurate but it is not universally true. Residual oil at $1 per barrel at the refinery corresponds in Btu. to $4 per ton coal at the mine. Good coal can be purchased today at $2.75 per ton on cars at the mine, this corresponds to $0.70 per barrel of saleable oil which is considerably below the prices quoted in this paper. Freight differentials would have to be calculated to arrive at a satisfactory comparison. This type of analysis can be accurately made only for a specific situation. The authors would prefer to leave this work to individuals who are more familiar with the market situation.

Question 3—What happens to the 4-percent sulfur, nitrogen, and oxygen in the charge?

Answer—It is converted to NH_3, H_2S, and H_2O. Most of it would be present as ammonium sulfide in water solution, the balance would be in the gas stream returning to plant fuel.

Question 4—Most of the data used are obtained from German sources, would these data apply equally as well to American conditions?

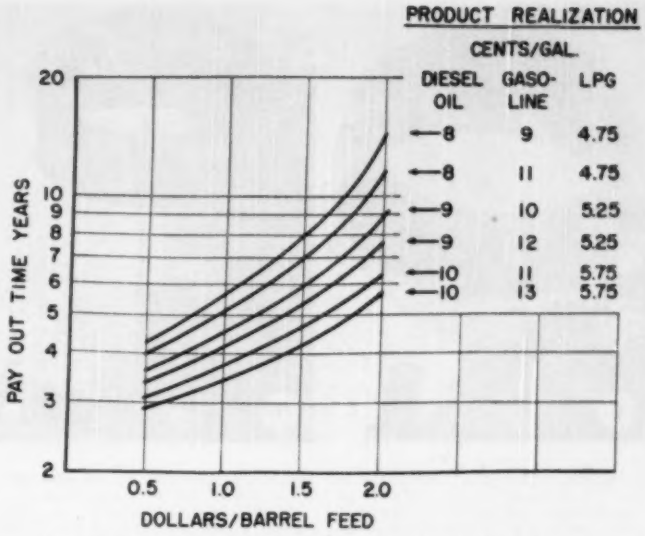


Figure 3. Effect of Feed Price on Pay-Out Time for Various Product Realizations.

Answer—The German experiments were carried out on crudes obtained from American sources. The problem they were attempting to solve was the production of gasoline and distillates from the cracking residues from such crudes. It is doubtful if any great deviation is to be expected from the German data. As pointed out in the paper, experimental data for a specific raw material would be necessary before actually designing a plant.

Question 5—Is the extensive use of heat-exchange equipment justified?

Answer—The cost of fired preheaters is considerably greater per unit of heat absorbed than the shell and tube exchangers. Likewise, high-pressure water coolers are quite expensive. For these reasons it is doubtful if any appreciable saving could be realized by eliminating heat exchangers.

Question 6—Are the indicated reactor sizes practical?

Answer—Designs for 700 cu. ft. converters operating at 700 atmospheres have been furnished by two American forge companies. Such converters would be practical only in large plants. The number and size of converters for small plants should be calculated on the basis of the particular conditions.

Question 7—The amount of fuel provided for the hydrocarbon steam-cracking unit appears inadequate.

Answer—This is a case where fuel cost vs. exchanger surfaces would have to be determined on the basis of local conditions. The plant cost cited is for complete heat recovery in the hydrocarbon steam-cracking plant. Under these conditions the amount of fuel gas shown is adequate. If an economic study resulted in the elimination of some of the heat-recovery equipment it would not affect the cost of the end product unfavorably.

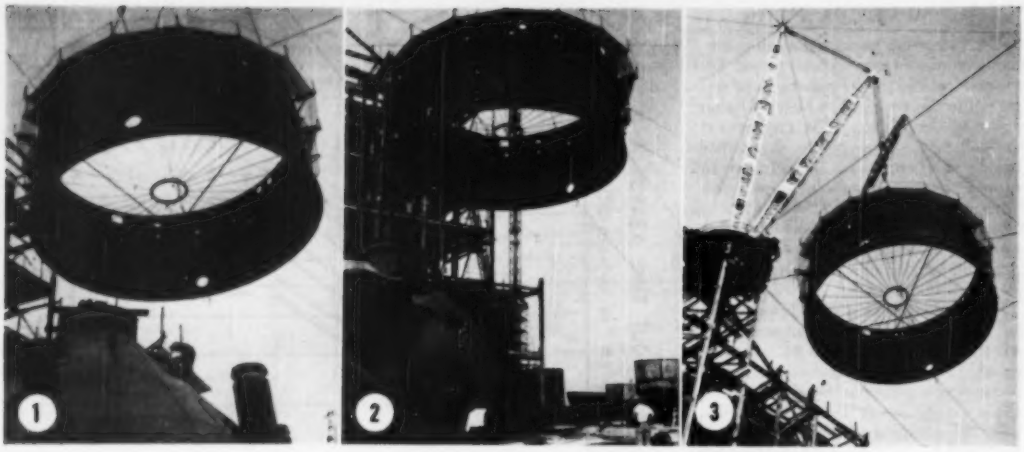
Question 8—The assumption is made that the product streams as cut on the unit would have finished product value. Is this true?

Answer—The gasoline would be quite heavy. In a few cases this would be a disadvantage, in most cases the ability to blend with natural gasoline would enhance the value of this product. The distillate cut would meet most diesel fuel specifications; deviations, if any, would be so slight that they could only be determined after actual operation. Changes in catalyst or operating conditions are all that would be required to make the necessary corrections.

Question 9—Due to the limited market for diesel fuel, wouldn't it be wiser to evaluate the distillate oil as No. 2 fuel?

Answer—In some localities this may be true, the increased demand for jet and diesel fuels has convinced the authors that in most cases this material can be readily disposed of as a finished product superior to No. 2 fuel oil.

* * *



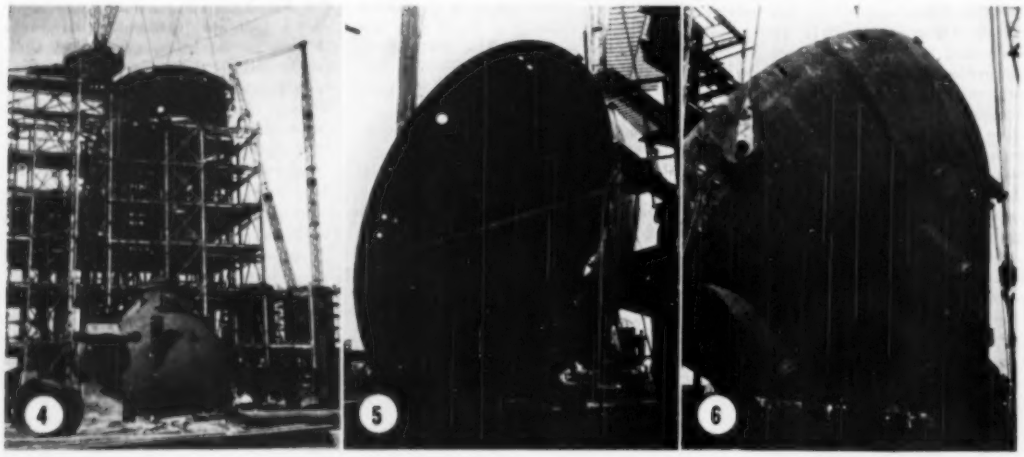
Engineers of Three Nations Construct Big Cat Cracker

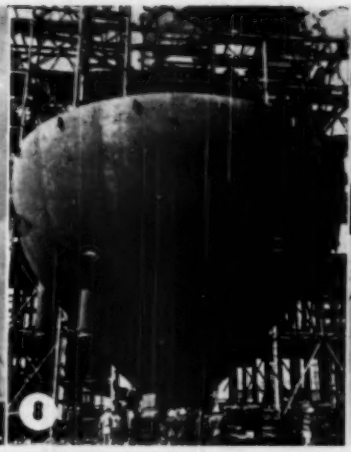
Field Assembly of Abadan Fluid Cat Cracker Shown by Series of Naft Photographs

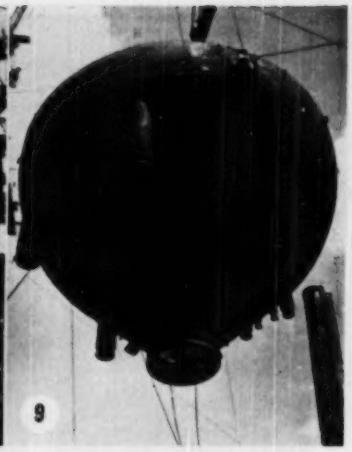
PROBABLY the largest pressure vessel used in petroleum processing plants are the regenerators of the fluid catalytic cracking units. These vessels must operate at high temperatures. Accordingly, they are designed with refractory linings to allow the use of reasonably high metal stresses in their walls. Their size and elevated location incur heavy wind loads that combine with loads from internal operating pressures and various structural loads. The metal walls must be heavy. The erection of one of these vessels is a major construction project.

Photographs of the field erection of the regenerator at the new fluid catalytic cracking unit of Anglo-Iranian Oil Company at Abadan in Iran show the procedure followed in handling this construction problem. British, American and Iranian engineers and technicians all are cooperating in construction of the plant. Included are the American firms of Foster Wheeler Corporation and E. B. Badger & Sons.

Photos 1 and 2—The skirt section or "ring," 47 feet in diameter and weighing 75 tons, is lifted from a position near the base of the catalytic cracking unit structure. The skirt ring was fabricated







by electric arc welding, at ground level, from heavy steel plates that were shop cut and rolled to shape before shipment to the refinery site.

Photo 3—The skirt is lifted by a specially installed erection crane, high on the catalytic cracking unit structure. The crane itself is a large piece of equipment that was raised into position as the framed steel process unit structure was assembled step-by-step. When the process unit is complete, the crane will likewise be taken down by a step-wise procedure, somewhat like that used in the erection of high buildings.

Photo 4—The skirt is positioned just over its intended location. It will be lowered to rest on the steel structure which has been specially designed to accommodate the heavy loads of vessel weight and operating loads of many tons of catalyst.

Photo 5—The regenerator bottom section or "cone" was also fabricated at ground level from specially shaped plates. (In Photo 4 this section can be seen in the "upside-down" position in which it was assembled and welded.) Here, Photo 5, the "cone" is being turned over preparatory to being incorporated into the regenerator.

Photo 6—Same as Photo 5. The main connection at the small end of the truncated cone will be the spent-catalyst and carrier air inlet when the unit is completed. The smaller connections are for various catalyst withdrawal standpipes. On these, the provision of space for their refractory linings can be noted. The nozzle necks are tapered near each flange.

Photo 7—Rigging is in position for lifting the bottom cone.

Photo 8—The cone is clear of the ground. The cone weighs over 100 tons and the load must be raised 160 feet and lowered on to the skirt section which is in place. The workers seem to have unlimited confidence in the planners and executors of the project!

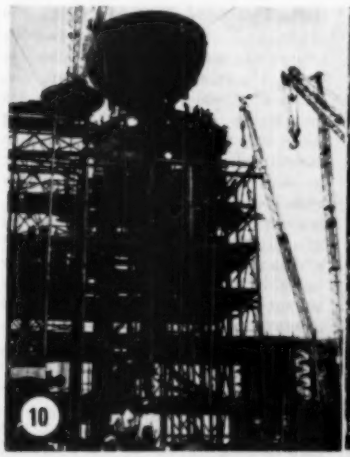
Photo 9—Cone being lifted into position.

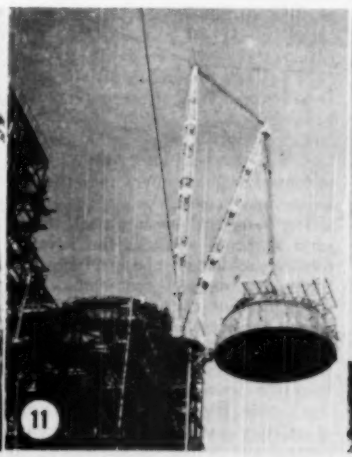
Photo 10—The cone is over the skirt section and now will be lowered to rest on this support. Workers will guide it to the exact position desired. The crane operator can position the cone very closely, but some heaving and hauling will doubtless be needed to set the cone at the correct rotational angle.

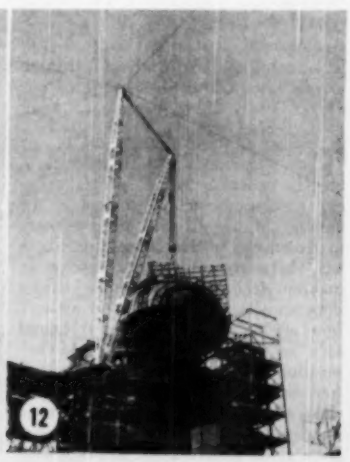
Photo 11—The regenerator has side walls that make up a straight cylindrical section. These rings were assembled on the cone section by welding on more rolled plate sections, the crane also serving to lift this steel into place. Here, Photo 11, the top head section for the regenerator is being lifted into place from its ground-level assembly location. The beams that can be seen at the lower plane of this head serve as stiffeners and will aid in fitting it to the straight wall section of the regenerator. Walkway and operating platforms framing already assembled on the head will be useful to the riggers, and their attachment at ground level allows some saving in erection work.

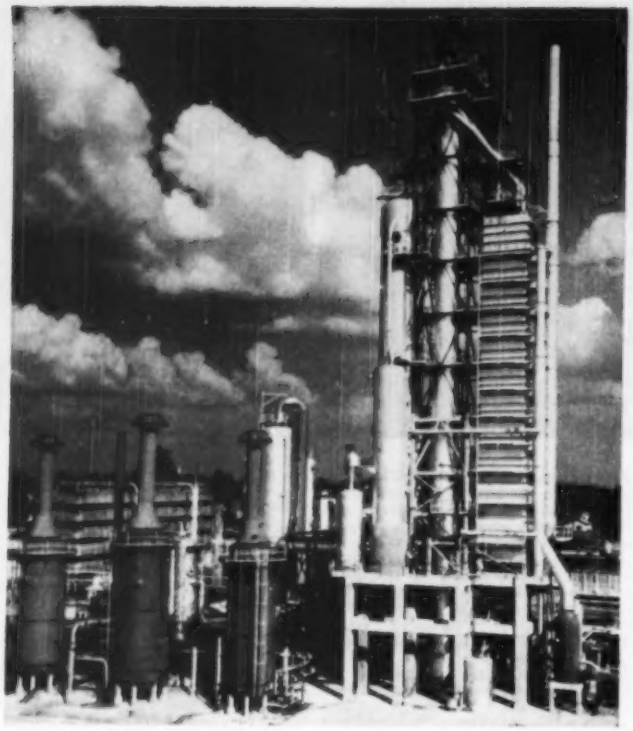
Photo 12—Top section has been raised some 185 feet and is being swung into position. When this section has been finally located, welded, and any other necessary vessel wall welding finished, the regenerator shell will be complete. Lining, piping, and other process equipment construction work will still require months of work before the catalytic cracking unit can be placed in service.

All photos and data are used here through courtesy of Naft Magazine, published by Anglo-Iranian Oil Company, Ltd., London.









Operating Alternatives On Basis of Cost Analysis

JOHN L. FOX
Emlenton, Pa.

THE criterion upon which refinery costing should be judged is the amount of aid it will offer refinery management. Will costing efforts be a real help to refinery executives in making decisions involving a choice between alternative courses of action? Too often this objective is relegated to a secondary position, the primary position being taken by an attempt to find the "actual" unit costs. At the risks of seeming dogmatic, it would appear that the emphasis which has been given to allocation of crude cost to refined products offers no particular aid to management.

The more realistic approach would seem to be to consider the refiner's costing problem as one involving differential costs and cost analysis. A differential or incremental cost represents the net effect of the choice of alternatives. These alternative courses and the differential costs associated therewith from the subject matter of this article. However, some knowledge of refinery processing is a necessary prerequisite to an understanding of the problems requiring a choice between alternative courses. For this reason, the paragraphs which immediately follow offer a simplified explanation of these processes and the questions of choice which they raise.

Emergence of Intermediate Distillates

Refining, in its elementary form, involves vaporizing of the crude oil by heating it to a high temperature, collecting the resulting vapors, and condensing them back into a liquid state. The basic petroleum products are obtained through a physical change caused by the application of heat through a wide temperature range. The initial application of heat drives off the lightest fractions, the naphthas and gasoline; the successively heavier fractions, such as kerosine and gas oil, follow as the temperature rises. This process of vaporizing the crude and condensing the gaseous vapors to obtain the various "cuts" is commonly referred to as primary distillation. Certain of these cuts are marketable with but little treating while it is necessary for the others to undergo further processing in order to make them more readily salable and, therefore, more valuable. Thus, heavier fractions, such as kerosine and gas oil, may be subjected to cracking and consequently made to yield a more valuable product, i.e., gasoline. The heaviest of the fractions resulting from primary distillation is known as residuum or heavy bottoms. This residuum, after processing, treating, and blending, forms lubricating oils and ancillary wax or asphalt products.

The unit which brings about this physical separation of the crude oil

WHAT WILL happen "if"? Perhaps the accountant has not been telling management all he knows — or could know — about the relative costs of alternative courses of action. The present article, related to the circumstances of petroleum refiners, develops a tool for this purpose on the flexible budget principle and offers applications in five situations.

The article appeared originally in the December, 1949, issue of the National Association of Cost Accountants Bulletin. The author is a staff member of a large public accounting firm.

into its component fractions might be thought of as constituting the primary process in refining. As the primary process, it separates the various fractions which may serve as charging stocks for the secondary processes. The term "charging stock" as used in refining terminology refers to unfinished products which are to be further processed in some secondary refining operation. These secondary processes constitute additional refinery treatments which either result in new products or bring primary products up to required quality standards. The charging stocks or intedmediate distillates resulting from primary processing usually include the following: naphtha, kerosine, distillate fuel oil, gas, oil, wax distillate, 600 steam refined stock (cylinder stock).

Buy and Process? Sell or Process Further?

The real problem facing refiners is in deciding whether to purchase intermediate distillates for further processing or whether to sell intermediate distillates on hand without further processing. The general underlying factor which is responsible for the emergence of this problem is the inherent nature of petroleum refining. Refining requires the separation of *all* the fractions from the crude oil even though only one or two may be desired. Increased demand for one fraction may result in an oversupply of complementary fractions. The refiner must be continually deciding what to do with all the fractions, not just the one which forms the basis for the product in highest demand.

This involves determining at what stage of refining each product or stock will ultimately be sold and also what routing will be used. Certain fractions can be sold with little secondary processing. These include naphtha, kerosine, and distillate fuel oil. However, by making use of alternate routings these three cuts can be cracked to produce gasoline and some fuel oil. Another phase of the same problem arises in connection with the lubricating stocks, wax distillate, and 600 steam refined stock. Wax distillate yields viscous neutrals and paraffin wax while the 600 stock results in bright stock and amorphous (black) wax. The finished motor oil is a blend of the light, clear neutrals and the heavier, darker bright stock. These lube stocks may be salable at various gradations of processing or quality refinement.

Still another phase of this problem is the possible purchase of distillates offered for sale by other refiners. The choices of the preceding paragraph are not just a one-way proposition. It may be possible to buy certain stocks at various stages of refinement and transform them into products of higher commercial value. For example, the refiner may purchase 600 stock and refine it into finished bright stock.

Selection of Alternatives

Raw crude cost constitutes from 75 to 85 percent of the total cost of all refinery products. Consequently, the margin of profit is actually dependent upon what products are obtained from the crude oil rather than upon fluctuations in operating expense. Thus, the refiner must produce the right product at the right time. Production planning can make or break the refiner. This planning should be based upon quantitative as well as qualitative factors. Too many refiners base their production policies entirely upon the latter aspects. It is up to the accountant to furnish management with information regarding the quantitative elements which should play a large part in influencing managerial decisions.

The dominant factors influencing the refiner's choice of alternate courses might best be termed qualitative variables. This bias toward the qualitative aspects of certain problems may at times result in the refiner unknowingly following an unprofitable course of action. However, these factors must not be ignored but should be considered along *with* the quantitative elements.

Complicated Buy and Sell Choices

Charging stocks are likely to be quite heterogeneous, due to the vagaries of refinery type, degree of refinement, and the type of crude from which they originate. Consequently, it is necessary for the vendor to state the characteristics of the stock such as flash point, viscosity, etc. The purchasing refiner will first consider his possible selling price for the potential finished products contained in the charging stock, then he will try to decide how much he can profitably pay. "Rule of thumb," as applied by a shrewd and experienced executive, usually determines the price, quantity, and type of stock purchased or sold.

Price situation and market trends—Management's view of market trends in regard to individual products is an important factor in its decisions. If it appears to management that fuel oil is going to rise in price, then gas oil may be held for later sale as fuel oil rather than used currently as a charging stock for the production of additional gasoline.

Bargaining element—Since there are no published markets for unfinished products, the element of bargaining plays a large part in the final purchase or sale. Refiners get an idea of the current worth of the various stocks from a daily price reporting service. This is probably the only printed source on current pricing of the intermediate distillates and, as such, represents the opinion of the reporting service, not a published market.

Commitments—A refinery may have certain marketing commitments, which would make complete flexibility of action impossible. Such marketing agreements may require continued production of one end product even though an alternate routing would be more profitable at the moment.

Dumping—A refinery may find that it can materially increase its sales volume and utilize all available capacity by selling part of its production at a reduced rate. Before such a step is taken, management should contemplate what effect this policy will have on existing sales at established prices.

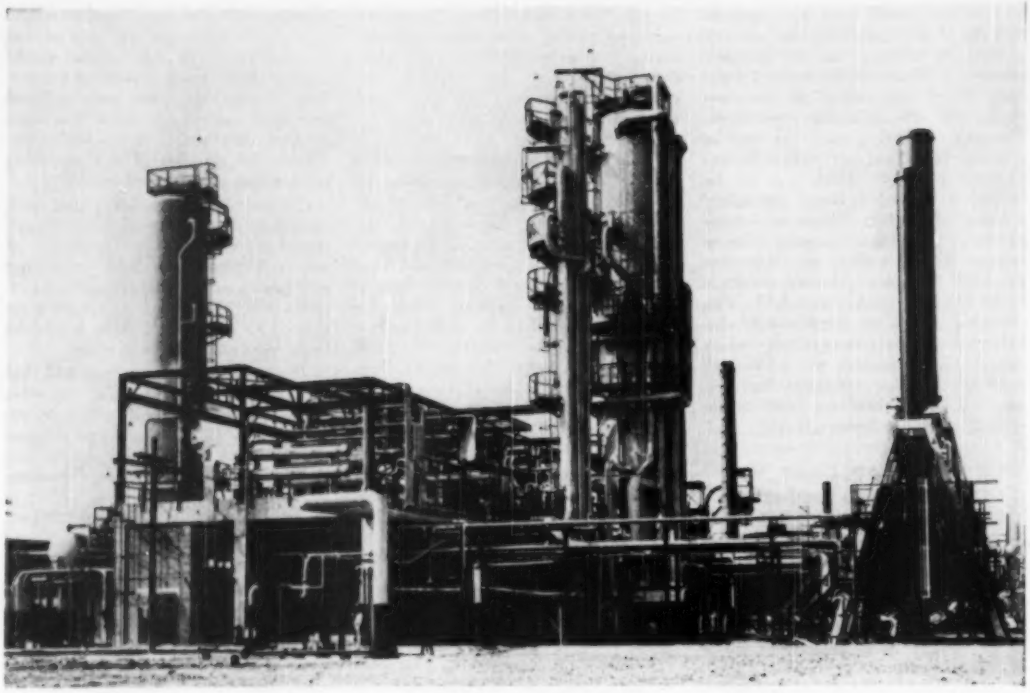
Available capacity—A refiner would have to pass up potentially profitable purchases if secondary refining units were already scheduled for 100 percent of capacity. Imbalance in the secondary refining units as a result of differing departmental capacities could definitely influence the selling or purchasing of intermediate stocks.

New units—A refinery may have purchased new units for use in certain secondary processing operations. It might be profitable to buy additional charging stocks on the open market for these units. Conversely, if a refiner were using obsolete equipment in a secondary refining operation, he could well be high-cost producer. Sale of the pertinent charging stocks might be more profitable than using the old unit.

Storage space—At times practically every tank in a refinery may be full. This condition could affect the refiner in two ways. First, opportune purchases of intermediate distillates could not be consummated. Second, the refiner may be required to sell certain stocks currently being produced at whatever price they can be moved, due to lack of tankage. Perhaps the demand for fuel oil and lubricating stock makes increased production desirable. Yet an increase in such production might not be feasible because of lack of space to store kerosine and other resulting "joint products."

Differential Cost and Differential Income

No really analytical or scientific approach to the refiners problems in this whole area can be made without accurate and timely cost data. Cost



must be regarded in an alternative sense, rather than stressed in its absolute and historical aspects. Alternative costs should reveal the favorable and unfavorable sides of any given decision and offer an anlytical comparison between possible policies or actions. This alternate type of approach to the problem requires the use of differential analyses based on differential costs taken from departmental flexible budgets. As previously stated, differential costs represent the net effect of the choice of alternatives.

The differential idea might be illustrated by a simple example. A refiner has a supply of kerosine on hand. He wishes to know if he should sell it as kerosine or use it as charging stock for cracking. It should be evident that he can not make a really intelligent decision unless he knows the incremental cost of cracking the kerosine supply. The differential cost will be the cost associated with cracking that kerosine. It is the difference between the cost that will be incurred by the cracking department at the consequent higher level of production and the cost incurred at the present volume of production. The differential income is the difference between the potential revenue from the cracked kerosine (i.e., gasoline and residual fuel oil) and the revenue available from the sale of kerosine, as such. If the differential income exceeds the differential cost, then the further processing is justified cost-wise.

Departmental Cost Analysis Budgets

The cost accountant can help management most through the preparation of departmental cost analysis budgets for the secondary operating departments (i.e., cracking, treating, solvent dewaxing, solvent extraction, etc.). In this way management will know the differential costs upon which many important decisions are now based, either knowingly or unknowingly. If these cost analysis budgets can set forth differences in price or income resulting from alternative courses, then they will have more than contributed to profitable operation.

Cost analysis budgets differ from control budgets in several respects. All expenses are included in the analysis budgets. The budgeted expenses of the service departments are allocated to the operating departments at the corresponding capacity levels. In order to distribute these service department expenses properly, they must be separated into fixed and variable components. Then each will be distributed on its proper basis.

The number of percentage capacity intervals budgeted will vary with individual plant need and the availability of information. As data is accumulated regarding past behavior of expense patterns, it should be possible to budget in smaller graduations of capacity. The goal of these analysis budgets is to discover the departmental differential unit costs. These differential costs represent expenses specifically incurred for an additional increment of production. They are costs directly associated with and assignable to the incremental increase in the volume of production.

Exhibit 1 is illustrative of a cost analysis budget of the sort here advocated. The amounts to be stated for each class of expense at each production level must be arrived at on separate work sheets on which the various individual expenses are separated into their fixed and variable elements. This separation is necessary to arrive at the estimated expense for each level of production.

The remainder of this article is devoted to five examples illustrating the use of differential cost data in the solving of several hypothetical problems involving a choice between alternative courses of action open to oil refiners. These illustrations should not be construed as an attempt to prove the infallibility of analysis budgets

Differential costs cannot eliminate the risk of wrong decisions. However, differential costs as presented in the analysis budgets should definitely limit the chance of making an improper decision. An analysis of this type should translate hunches, guess work, and instincts into reasonably logical conclusions.

An alert refinery management will immediately recognize the value of a good quantitative approach to its problems. This does not mean that the management will disregard the qualitative influences previously described. Such factors as the effect of dumping, market commitments, and available storage space will definitely be considered. However, with only the qualitative influences to go by, management is likely to make many wrong decisions that could be avoided if the proper cost information were available.

Application 1—Sell or Process Further

A refiner has on hand 20,000 gallons of fuel oil. He must decide whether to sell it as fuel oil or crack it into gasoline and residual fuel.

The following facts are available:

Current prices: Fuel oil 7 cents per gallon, gasoline 14 cents per gallon.

Cracking department analysis budget: Present operations 80 percent of capacity.

Differential cost (80 to 100 percent) = 5 cents per gallon.

Cracking yields: 75 percent gasoline, 15 percent residual fuel oil, 10 percent loss.

The refiner can then prepare the following analysis regarding the decision to be made:

Differential Income and Cost Computations

Potential Revenue—Products from Cracking:	
Gasoline 15,000 gal. @ 14¢	$2,100
Fuel Oil 3,000 gal. @ 7¢	210
	$2,310
Less. Potential Revenue—Fuel Oil:	
20,000 gal. @ 7¢	1,400
Differential Income	$ 910
Less. Differential Cost:	
20,000 gal. @ 5¢	1,000
Loss from Cracking of Fuel Oil	$ 90*

* Not an accounting loss, per se but a loss of profit which would result from an improper choice of alternatives.

Thus, judging from a quantitative standpoint, it would be more profitable to sell the 20,000 gallons of fuel oil, as such, rather than to process it further.

Application 2—Price to Pay for an Intermediate Stock

A refiner has been offered 10,000 gallons of cylinder stock. The usual bargaining process will determine the final price. The would-be purchaser is interested in knowing how high a price he can pay and still make a profit.

The stock purchased would be processed into conventional bright stock and sold at that stage, since the blending unit for making finished motor oils is currently working at full capacity. The information available is as follows:

Cylinder stock is of such a quality and type that it will probably yield: 90 percent bright stock, 5 percent petrolatum, 5 percent loss.

Current prices: bright stock 50 cents per gallon, petrolatum—no market.

Differential costs associated with processing 10,000 gallons of cylinder stock through several units (from analysis budgets):

Solvent dewaxing	2 cents per gal.
Solvent extraction	2 cents per gal.
Filtering	1 cent per gal.
Total	5 cents per gal.

Using this information, the refiner can analyze his position and determine his bargaining margin, as follows:

Margin Establishing Limit of Purchase Cost

Revenue—bright stock 9,000 gal @ 50 cents	$4,500
Differential costs, 10,000 gal @ 5 cents	500
Margin	$4,000

$4,000 ÷ 10,000 gal. = 40 cents (point of no advantage)

The refiner is now ready to bargain for the purchase of the cylinder stock. He knows that a purchase price of forty cents a gallon represents his "break-even" point. To pay more would produce a loss, to pay less would result in a gain. He then makes his decision as to how much profit is required to justify the purchase. Here the concept of opportunity costs also enters into the final decision. If the available capacity could be more profitably used for another purpose, then perhaps the proposed purchase should not be consummated.

Application 3—Choice of Alternate Routings

A refiner is trying to decide whether to treat and sell the kerosine fraction or to crack it for gasoline content. The current decision involves 10,000 gallons of raw kerosine. The pertinent information available to him is as follows:

Current prices: kerosine 8 cents per gallon, gasoline 14 cents per gallon, fuel oil 7 cents per gallon.

Cracking yields: gasoline 85 percent,

EXHIBIT 1

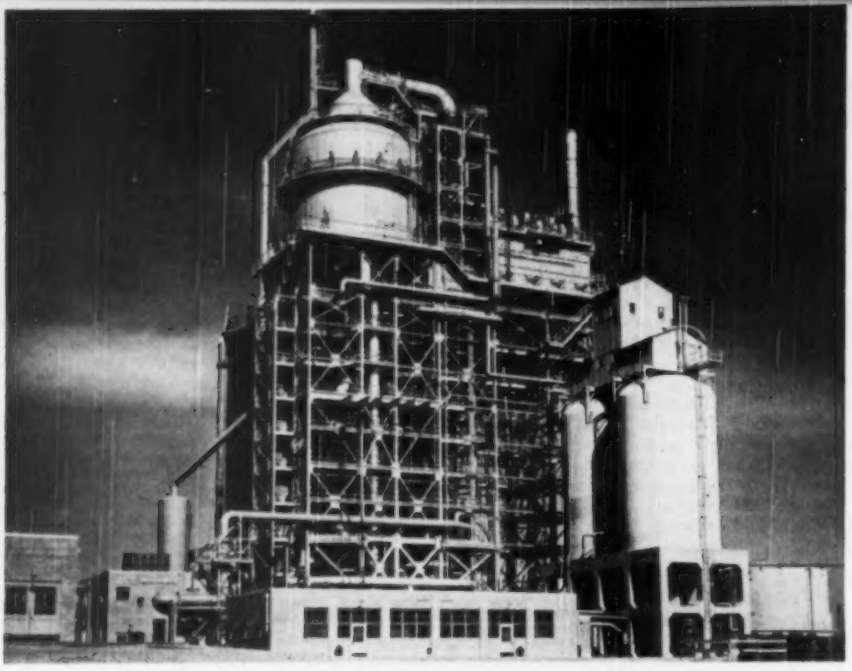
Cost Analysis Budget

Department: Cracking Period Budgeted ..... To .....

Supervisor ..... Normal Capacity (100%) 100,000 Gallons Thruput

Department and/or Expense Account		Shut-down	60%	80%	100%	120%
Direct Expense:						
Direct labor	53-1					
Superintendence	53-2					
Supplies	53-3					
Repair materials	53-4					
Repair labor	53-5					
Depreciation	53-6					
Fuel—Natural gas	53-7					
Fuel—Cracking plant gas	53-8					
Royalties	53-11					
Miscellaneous	53-12					
Clean-out expense	53-16					
(Gas produced)	(53-20)					
(Fuel oil—produced and used)	(53-21)					
		$3,000	$7,000	$8,000	$8,500	$11,500
Allocated Expenses:						
Fixed:						
Power and boilers	60					
Control laboratories	61					
Research laboratories	62					
Water plant	63					
Storage tanks	64					
Operational overhead	65					
General refinery overhead	66					
Variable:						
Power and boilers	60					
Control laboratories	61					
Research laboratories	62					
Water plant	63					
Storage tanks	64					
Operational overhead	65					
General refinery overhead	66					
		$ 500	$1,000	$1,500	$2,000	$ 3,000
Total Costs		$3,500	$8,000	$9,500	$10,500	$14,500
Thruput:						
Total gallons		0	60,000	80,000	100,000	120,000
Differential gallons		0	60,000	20,000	20,000	20,000
Differential cost			$4,500	$1,500	$1,000	$4,000
Unit differential cost			$.075	$.075	$.05	$.20
Unit average cost			$.133	$.119	$.105	$.1208

Captions in brackets ( ) call for red figures.



residual fuel oil 5 percent, loss 10 percent.

Differential costs associated with potential gallons thruput (from analysis budgets): cracking 3 cents per gallon, treating 1 cent per gallon.

Using the above amounts, the refiner can prepare the following analysis:

Differential Cost and Income—Alternative Routings

Net Potential Revenue—Products from Cracking:		
Gasoline 8,500 gal. @ 14¢	$1,190	
Fuel Oil 500 gal. @ 7¢	35	
	$1,225	
Less: Differential cost, 10,000 gal. @ 3¢	300	$925
Net Potential Revenue—Kerosine:		
Total Revenue, 10,000 gal. @ 8¢	$ 800	
Less: Differential cost, 10,000 gal. @ 1¢	100	$700
Gain from cracking rather than treating.		$225

In this situation, it is apparent that the more profitable alternative is to crack the kerosine fraction.

Application 4—Proposed Construction of Additional Capacity

A refiner discovers that the market for finished neutrals is such that his present capacity does not satisfy the demand. He feels certain that an addition to the solvent dewaxing and solvent extracting units would prove profitable. The additional wax distillate stock required would be purchased on the open market at the current rate. However, before going ahead with the construction he first consults the chief accountant, who presents the following analysis based upon the analysis budgets:

Unit differential cost of increasing operational capacity from 100 percent to 120 percent (10,000 to 12,000 gallons):
Solvent dewaxing department ....10 cents per gallon thruput
Solvent extracting department ....10 cents per gallon thruput

Assumed yield from wax distillate: 90 percent viscous neutral, 5 percent paraffin, 5 percent loss.

Current market prices: Viscous neutrals 47 cents per gallon, white crude scale wax 8 cents per pound, wax distillate stock 35 cents per gallon.

On the basis of the foregoing data, an appraisal of the situation is worked up, much as in the case of the applications which have already been cited:

Schedule of Projected Action

Differential Income (100% to 120% of Capacity):		
9,000 gal. viscous neutral @ 47¢	$4,230	
1,200 lbs. paraffin @ 8¢	96	
	$4,326	
Less: Cost of wax distillate stock 10,000 gal. @ 35¢	3,500	
Margin to apply against differential costs		$ 826
Differential Costs:		
Solvent Dewaxing Department 10,000 gal. @ 10¢	$1,000	
Solvent Extracting Department 10,000 gal. @ 10¢	1,000	2,000
Potential loss from differential production		$1,174

It would appear from the accountant's analysis that the proposed increase in the productive capacity would not be justified.

Application 5—Shutdown Considerations

The analysis budgets should provide important data for use in making decisions regarding possible shutdowns. The fact that an operating department is a high-cost type due to obsolescence may not, for that reason alone, justify its removal from the active list. In making the final decision as to shutdown, the refiner should remember the contribution approach and judge the situation in that light. Under this theory, each dollar of revenue contributes first to variable expenses, then to fixed costs and profits. This marginal contribution to overhead and profit should not be overlooked. A unit that is recovering more than just "out-of-pocket" expenses is making a definite contribution to overhead. The fact that it is not making a profit does not mean that it is not contributing. Unless the unit to be substituted will contribute a sufficiently higher marginal contribution, it would be unwise to arbitrarily shut down an "unprofitable" unit.

Value of Cost Analysis Budgets

This article, with its various illustrative applications, has attempted to show a few of the uses of cost analysis budgets in helping the refiner choose between alternative courses of action. Differential costs derived from these budgets should prove of daily value in meeting many and varied problems. The use of such accounting tools interjects a dynamic quantitative element into everyday management problems.

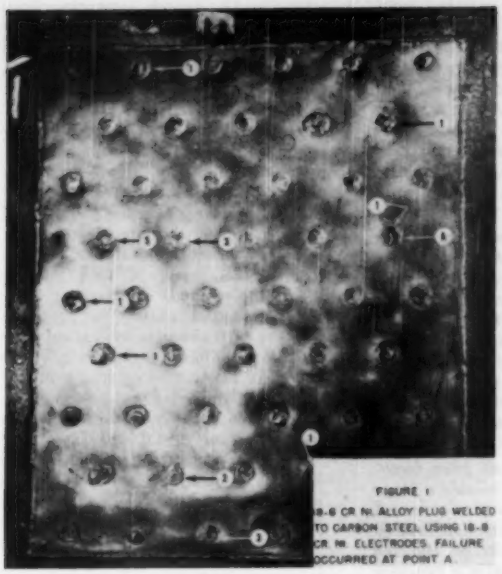


FIGURE 1
18-8 CR NI ALLOY PLUG WELDED TO CARBON STEEL USING 18-8 CR NI ELECTRODES. FAILURE OCCURRED AT POINT A.

Figure 1. 18-8 Chrome Nickel Alloy, Type 304. In a sheet 3/32" x 24" x 30", holes 15/16" in diameter were punched on 4" triangular centers, and the sheet was then plug welded to a ½" x 30" x 36" carbon steel base plate. The four edges of the alloy sheet were fillet welded to the base plate with the same type of electrodes. One ½" hole was drilled and tapped through the center of the carbon steel base plate so that the sample test plate could be connected to a pump. Oil was introduced between the base plate and the alloy liner for a pressure test of the lining material. A gauge was placed in the circuit to indicate pressure. At 200 psig. pinhole leaks appeared as indicated by the numbers "1". These leaks were welded over. Pressure was returned and a pinhole leak appeared in a weld at 300 psig. indicated as "2". This leak was welded over and pressure again applied to the test plate. At 400 psig., four leaks appeared, one a rupture at the junction of the weld metal and the alloy sheet, letter "A". The other three leaks are marked "3". The lining material began to bulge at 225 psig.

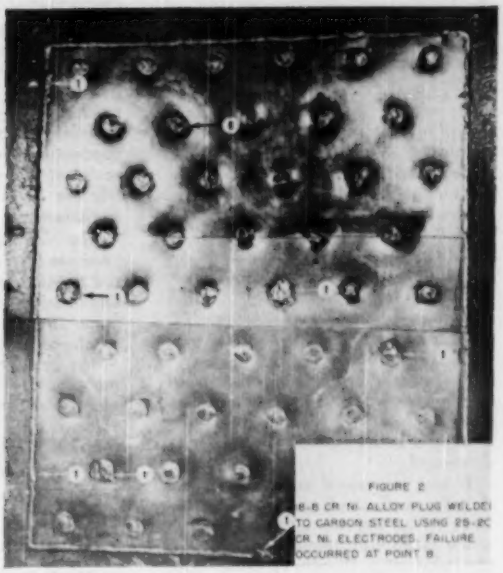


FIGURE 2
18-8 CR NI ALLOY PLUG WELDED TO CARBON STEEL USING 25-20 CR NI ELECTRODES. FAILURE OCCURRED AT POINT B.

Figure 2. 18-8 chrome nickel alloy, type 304, plug welded to a carbon steel base plate, using 25-20 chrome nickel electrodes. This specimen was prepared as noted in Figure 1. At 300 psig., leaking occurred through pinholes in four plug welds and at three places along the outside seam. These leaks are indicated by the numbers "1". These pinholes were repaired. At 450 psig. a rupture occurred at the junction of the weld metal and the alloy sheet at the plug weld indicated by the letter B. The first apparent bulging of the lining material occurred at 250 psig.

Corrosion Resistant Liners In Refinery Vessels

G. C. CARPENTER

Esso Standard Oil Company, Louisiana Division, Baton Rouge

IN GENERAL, corrosion resistant liners are employed for reasons of economy. The natural constituents of the crudes being processed may corrode equipment or may give rise to corrosive agents during the distillation process. In addition, many processes take on a chemical aspect in that certain corrosive chemicals, such as sulphuric acid, hydrochloric acid, sodium hydroxide, and others, are utilized in the formation of desired end products. Specially designed equipment is necessary to safely and economically handle these corrosive chemicals, or alternately, old equipment must be suitably modified. Where the mass of metal valves, it has sometimes been found desirable to construct the equipment involved is small, such as tubes and

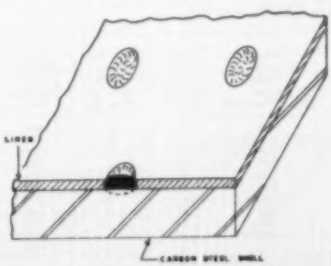


Figure 1-A. Plug Welded Liner Detail.

entirely of a material which will resist the particular type of corrosion encountered. Frequently, however, the size of refinery vessels precludes the use of expensive alloys as structural material, and in these cases, it has been necessary to use a combination of carbon steel for strength and a suitable lining material for corrosion resistance.

During the early years of the petroleum industry, equipment life was seldom a limiting factor in production. More recently, equipment life has sometimes limited the run lengths of crude processing units. While the cost of equipment replacement is high, the value of lost production may overshadow such replacement costs where equipment life limits run lengths. All economical considerations concerning corrosion resistant liners may be related to two factors:

1) The cost of lining a vessel and thereby assuring a long life versus the cost of more frequent replacement of the unlined vessel.

2) The effect that lining of the vessel will have on the time between shutdowns, particularly unscheduled shutdowns.

The use of metallic liners for refinery vessels at the Baton Rouge refinery goes back at least to 1915, at

which time certain processes involving the use of sulphuric acid necessitated the use of lead linings to prevent excessive corrosion. Throughout the 1920's, lead liners were used extensively in such vessels as lube agitators, refined oil agitators, and naphtha treating drums.

Development of chromium and chrome nickel alloys led to the exploratory use of alloy liners in the early thirties. In 1934, some vessels in the solvent recovery section of a dewaxing plant were lined with monel. A separator vapor line in thermal cracking service was lined with Inconel, and a bubble tower in this service was lined with 18-8 chrome nickel steel. General use of liners increased as the need for corrosion resistant equipment became more evident, and more and better lining materials were developed.

It was recognized at an early stage that the method of attachment of the liner to the interior of the vessel has much to do with the serviceability of the installation. Certain variables enter into the selection of a method of attachment. These include temperature variations of vessel and liner, weldability of the liner material to the vessel, desirable composition of the weld from a corrosion standpoint, and size of opening through which the liner material must be carried into the vessel. While it would be desirable to have a 100 percent bonded liner, this is not practical for large pieces of equipment which already exist in the unlined condition. Several methods have been used with varying degrees of success in the Baton Rouge refinery. These include plug welding and strip welding sheet metal to the vessel wall and lining by deposition of weld metal on a metal surface.

The early corrosion resistant alloy liners were without exception plug welded. **(See Figures 1 and 1-A.)** Small holes were punched on predetermined centers in the lining material, which was taken into the vessel to be lined in sheets as large as the manhole openings would allow. The liner sheets were backed up against the vessel shell, tacked into place, and subsequently welded to the shell at each hole with a suitable rod. Edges of the liner sheets were welded together and to the vessel shell. Soapy water was then spread over the lining surface and air pressure applied to the space between the shell and the lining. Pinholes and cracks could then be detected by the soap bubbles that formed on the interior surface. Plug welding proved rather undesirable because of the large number of small welds which provided numerous places for pinholes to occur. Leaks would break through in service, even after the liner had been made completely tight on installation, and the plug welds were virtually impossible to repair once they had been in service and leakage occurred **(Figure 2)**. These leaks did not result in further corrosion behind the liner but did permit the progression of fouling and coking between the liner and vessel wall to the extent that the liner would tear away from the attachment welds.

***CORROSION** has assumed more importance as a refinery problem as throughputs have increased and crudes have become progressively less sweet and more salty. This article presents certain problems and practices concerning the use of corrosion resistant liners to combat metal loss in refinery vessels and equipment.*

The author, who originally presented this material before the ASME Petroleum Mechanical Engineering Conference at Oklahoma City in October, 1949, is employed at Esso Standard's Baton Rouge refinery. This plant manufactures a wide range of petroleum products and a large volume of chemical products, some 700 products in all.

This refinery has been fortunate in having available a large quantity of relatively sweet Louisiana and Mississippi crudes. Spot sulfur checks of the ten principal crudes, over a two-year period, reveal that in eight of these sulfur content varied from 0.11 to 0.49 percent and these are considered to be sweet crudes. Two crudes showed 2.13 and 2.31 percent sulfur, respectively, and these crudes are the source of many corrosion problems. Average salt content of the ten crudes varied from 12 to 63.5 pounds per 1000 barrels during a recent 14-month period.

In 1945, the Baton Rouge refinery instigated a series of tests pertaining to the methods of attaching alloy liners to vessel walls. The principal purpose of these tests was to compare the plug welding method which was generally used at Baton Rouge at that time with the strip welding method. Five methods of attaching the alloys to the carbon steel base plates were used in making these tests. They were 1) plug welded, 2) strips welded to base plate and then butt welded together **(Figures 3, 3-A)**, 3) strips lapped and fillet welded with the unexposed edge continuously welded to the base plate **(10, 6-A)**, 4) strips lapped and fillet welded with the unexposed edge intermittently welded to the base plate **(6, 6-A)**, and 5) one-half the total number of strips used to be entirely fillet welded to the base plate, the spacing of these strips to be such that one strip should completely cover the space left and also lap over the strips on either side enough for a fillet weld to be made which would not be contaminated by the carbon steel base plate **(15, 15-A)**. Table 1 indicates the alloys used in the tests.

The plug welded linings were prepared by welding the alloy material to the base plates through 15/16-inch diameter holes punched on 4-inch triangular centers, as illustrated by **Figure 1-A.** The alloy plates were 3/32 inch thick, 24 inches wide, and 30 inches long. The carbon steel base plates were ½ inch thick, 30 inches wide, and 36 inches long.

The butt welded strip linings were prepared by first fillet welding the alloy strips to the base plate and then butt welding adjacent strips together, as shown in **Figure 3-A.** The individual strips were so spaced that their adjacent parallel edges were approximately 3/8 inch apart, thus allowing fillet welds to be made so that one did not overlap the other. The finishing butt weld between strips was then applied as a filler bead in such a manner as to overlap both adjacent fillet welds. The alloy strips were 3/32 inch thick, 4 inches wide and 30 inches long and the carbon steel base plates were similar to those used in making the plug welded samples.

The lapped and fillet welded strip

TABLE 1

SAMPLE	Lowest Pressure at Which Pinhole Leaks Occurred	No. of Pinhole Leaks at Lowest Pressure	Total No. Leaks Exclusive of Leaks at Rupture	Rupture Gage Pressure Psig.
1. 18-8 Chrome Nickel Plug Welded	200	6	7	400
2. 18-8 Chrome Nickel Plug Welded	300	7	7	450
3. 18-8 Chrome Nickel Strip Butt-Welded	150	2	6	600
4. 11½ to 13 Chrome Plug Welded	200	1	1	350
5. 11½ to 13 Chrome Strip Butt-Welded	300	2	5	800
6. 11½ to 13 Chrome Lapped and Fillet Welded*	200	1	1	330
7. Monel Plug Welded	200	4	4	575
8. Monel Strip Butt-Welded	100	3	8	525
9. Monel Lapped and Fillet Welded*	100	1	1	225
10. 18-8 Chrome Nickel Lapped and Fillet Welded†	270	1	1	320
11. Monel Lapped and Fillet Welded†		0	0	220

* Unexposed edge intermittently welded. † Unexposed edge continuously welded.

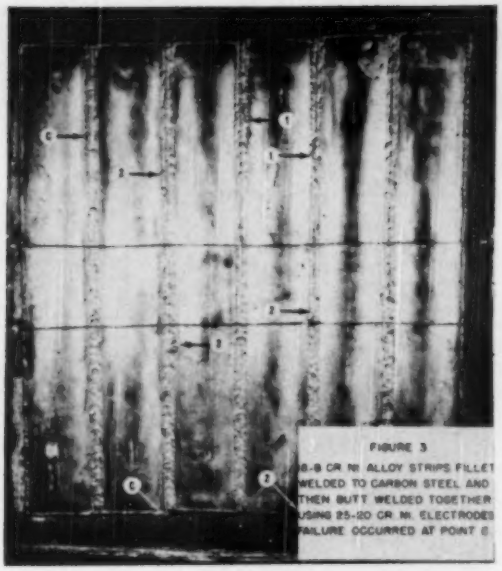


FIGURE 3
8-8 CR NI ALLOY STRIPS FILLET
WELDED TO CARBON STEEL AND
THEN BUTT WELDED TOGETHER
USING 25-20 CR. NI. ELECTRODES
FAILURE OCCURRED AT POINT C

Figure 3. 18-8 chrome nickel alloy, type 304, strips fillet welded to a carbon steel base plate and then butt welded together using 25-20 chrome nickel electrodes. Six 18-8 chrome nickel alloy strips, 3/32" x 4" x 30", were used. Each strip was individually fillet welded, on all edges, to a ½" x 30" x 36" carbon steel base plate. Spacing was such that the fillet weld beads of each strip were not tied into the fillet weld beads of the adjacent strips, but were so close that one filler bead could fill the gap between strips. Each layer of deposited weld metal was cleaned in the usual manner before any additional weld metal was added. The carbon steel base plate was drilled and tapped with six ½" holes located so that one hole was beneath each strip of lining material. A manifold was used to connect this test plate to the pump so that equal pressure could be simultaneously applied to each strip. A gauge indicated pressure. Pinhole leaks appeared at 150 psig. at locations indicated by "1". The leaks were welded over. Four more pinhole leaks appeared at 200 psig., marked "2". These holes were repaired. At 500 psig. two small ruptures occurred at the junction of the weld metal and the alloy material, "C". Pressure was increased without repairing the two ruptures and 1000 psig. was attained without any more ruptures occurring. Bulging became noticeable at 200 psig.

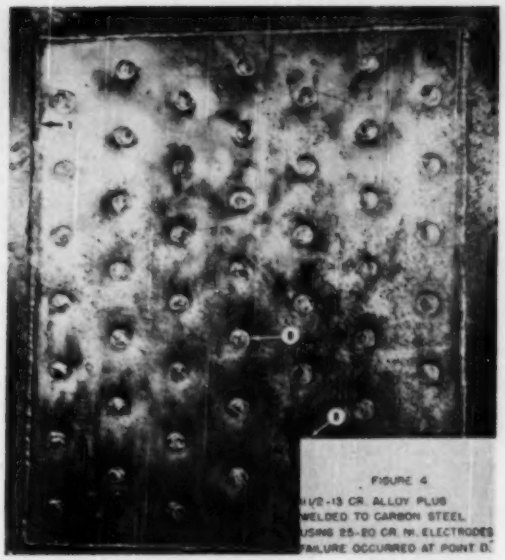


Figure 4. 11½—13 chrome alloy, type 410, plug welded to a carbon steel base plate using 25-20 chrome nickel electrodes. This test specimen was prepared as noted for Figure 1. At 200 psig. a leak in an edge fillet weld appeared at a point indicated as "1". This hole was welded over. Two ruptures occurred at 350 psig. These ruptures were at the junction of the weld metal and the alloy sheet, letter "D". Bulging began at 250 psig.

lining test plates were prepared by overlapping the adjacent edges of the strips approximately ½ to ¾ inch with the unexposed edge fillet welded to the carbon steel base plate, and the exposed edge fillet welded to the adjacent alloy strip, as shown in **Figures 6-A, 15-A.** In one set of two test plates, the fillet weld along the unexposed edge of the strip was intermittently welded, and in the other set of two test plates the fillet weld along the unexposed edge of the strip was continuous. The sample plates prepared with the intermittent weld were 3/32 inch thick, 4 inches wide, and 30 inches long, whereas the plate prepared with the continuous weld was 3/32 inch thick, 6 inches wide and 30 inches long. The carbon steel base plates making these samples were the same as in the previous cases.

The hydrostatic test of the sample lining installations showed that the quality of the finished and exposed welded joints was probably the most important single factor involved in any of the methods which were used. Referring to Table 1, it can be seen that a total of 41 pinhole leaks in the welded joints were found during the various tests and these leaks were exclusive of those which occurred at the time of complete failure of these test plates. From these tabular data, it is interesting to note that pinhole leaks were quite prevalent in both the plug welded and butt welded strip liners. Of the 41 leaks mentioned, 38 occurred in either one or the other of these two methods of installation. Of the four sample plates which were prepared by lapping and fillet welding the strips, one plate showed no pinhole leaks and the other three plates showed only one pinhole leak for each plate.

An additional purpose in applying hydrostatic tests to the sample liner installations was to simulate stressed conditions which exist during actual operation of lined vessels, where variations in temperature between vessel and liner, together with dissimilar thermal expansion coefficients, frequently cause high stresses at the points of attachment. From the test pressures shown in Table 1 which were required to cause the alloy liners to fail, it is readily noted that the strip welded liner with the strips butt welded together offers the greatest resistance to complete failure from pressure between the alloy and carbon steel plates. In this connection, it should also be noted that the lapped and fillet welded strip liners offer the least resistance to stresses set up by the hydrostatic force.

From the results of these tests, the different methods of installing alloy liners may be compared in the following manner.

1) Lining installed by plug welding.
Advantages—(a) There does not appear

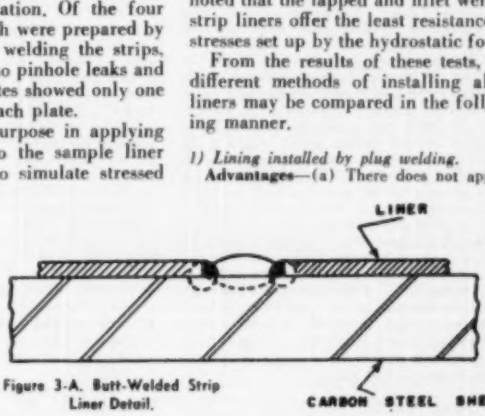


Figure 3-A. Butt-Welded Strip Liner Detail.

Figure 5. 11½—13 chrome alloy, type 410, strips fillet welded to a carbon steel base plate and then butt welded together using 25-20 chrome nickel electrodes. This test specimen was prepared as noted for Figure 3. At 200 psig. pinhole leaks appeared at points "1". After repair pressure was increased to 600 psig. before pinhole leaks again appeared, "2". After repair, two ruptures at the junction of the weld metal and the alloy strips occurred at 800 psig. These are points "E". Bulging became visible at 200 psig.

Figure 6. 11½—13 chrome alloy, type 410, lapped and fillet welded to a carbon steel base plate, the unexposed edge was intermittently welded to the base plate. 25-20 chrome nickel electrodes were used to do the welding. Six strips of 11½—13 chrome alloy, 3/32" x 4" x 30" were used. One strip was placed on a ½" x 30" x 36" carbon steel base plate and the top, bottom, and front edges were fillet welded to the base plate, the unexposed edge was intermittently fillet welded to the base plate with welds 3" in length and a 1" space between welds. The second strip was placed so that the front edge overlapped the intermittently welded edge of the first strip and was then welded in the same manner as the first strip. The third, fourth, fifth, and sixth strips were installed in the same manner except that the back edge of the sixth strip was continuously fillet welded to the base plate. One ½" hole was drilled and tapped through the center of the base plate for hydrostatic test purposes. At 200 psig. a pinhole leak appeared, "1". This leak was welded over. At 300 psig. a tack weld broke loose and at 340 psig. a second tack weld broke loose. In both instances the increase in volume caused a pressure drop. As the pressure was increased again a rupture occurred directly above the spot where the second tack weld broke loose, indicated as "F", at the junction of the weld metal and the alloy strip. The shock caused by the tack weld breaking evidently weakened the weld just above. The lining material began to bulge at 150 psig.

to be any distinctive advantage in this type of lining installation over the strip lining installation.

Disadvantages—(a) From every viewpoint which was considered, such as the quality of the finished weld, the ease of installation of lining plate and the cost of punching the holes for the plug welds, etc., this method of lining installation appeared to be inferior to the other methods tested.

2) Lining installed by the use of strips fillet welded to the base plate and then butt welded together.

Advantages—(a) This type offers the greatest resistance to any pressure force tending to pull it loose from the base plate due to the manner in which it is welded. (b) It offers the advantage of having a smooth finished surface which might make it more desirable for lining equipment, such as exchanger shells. (c) Narrow strips, which do not have to be provided with punched holes, can be taken into a vessel through any nominal size manhole without difficulty.

Disadvantages—(a) All the welding which is exposed to the action of any corrosive agent is more or less contaminated with the carbon steel or the base plate material. (b) The contamination mentioned in (a) makes it almost impossible to obtain nonporous welds and at the same time reduces the corrosion resistance of the weld in the case of non-ferrous liners.

3) Lining installed by the use of strips lapped and fillet welded with the unexposed edges continuously welded.

Advantages—(a) The weld metal exposed to the action of any corrosive agents is a 100 percent alloy weld, is not contaminated by any carbon steel or base plate material, and no weld which joins the alloy material to the base plate material is exposed. (b) There is less over-all welding exposed to attack by corrosion. (c) The size of each strip does not have to be exact and the strip edges do not have to be perfectly square, thus making the ease of installation attractive from an economical point of view. (d) Less welding is required in an installation of this type than is required in any of the other types, with the exception of that method which is similar to this one but is welded intermittently along the unexposed edges of the strips. (e) Narrow strips, which do not have to be provided with punched holes, can be taken into a vessel through any nominal size manhole without difficulty.

Disadvantages—(a) The only possible disadvantage of this type of alloy lining is the fact that it will not withstand as high a hydrostatic force tending to pull it loose from the base plate as will either the plug welded or the butt welded strip lining installations.

4) Strip welding with the strips lapped and fillet welded with the unexposed edges intermittently welded to the carbon steel base plate.

This type has the same disadvantages and advantages as the type under (3) above, except that it has the further disadvantage of not having as much strength to resist stresses between the lining and base plate, and it does not completely segregate each of the individual lining strips so that detection of any leakage in a welded joint for the purpose of making repairs would be extremely difficult after such a lining had been in service for an extended period of time. Therefore, whenever a lapped lining installation is indicated, the No. 3 type above should be used in lieu of this type.

5) One-half of the total number of strips used to be entirely fillet welded to the base plate, the spacing of these strips to be such that one strip will completely cover the space left and also lap over the strips on either side enough that a fillet weld can be made which will not be contaminated by the carbon steel base metal.

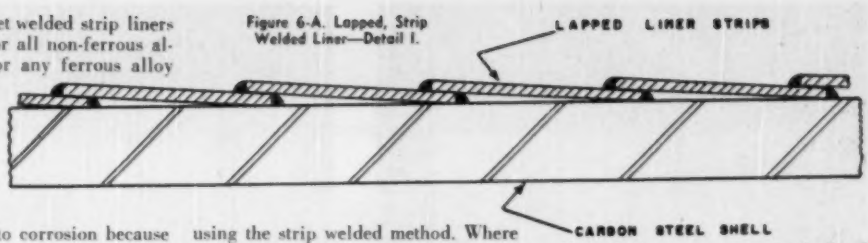
Advantages—(a) This method has the same advantages and disadvantages as those listed under No. 3 above, with an additional important advantage over the shingle method in the sequence of labor between the boilermakers and the welders. The boilermakers are able to place one-half the strips and then move out until such time as the welders have completed the welding of these strips.

As a result of these tests and the comparison it was concluded that:

1) Plug welded alloy liners should be discontinued.

2) Lapped, fillet welded strip liners should be used for all non-ferrous alloy lining and for any ferrous alloy lining where it is subjected to corrosion by aqueous solutions where there may be fear of the exposed welds being more subject to corrosion because of contamination by the carbon steel or base plate metal.

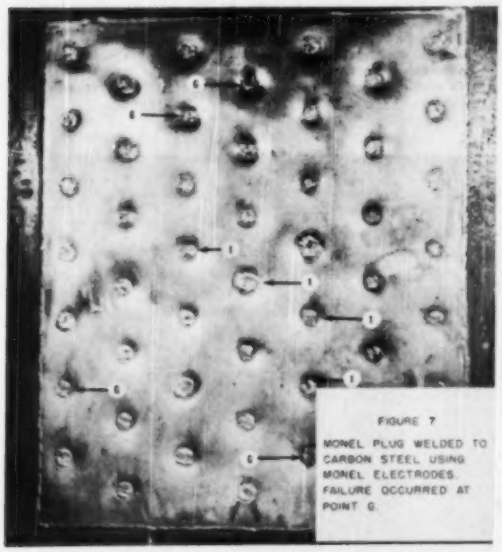
Figure 6-A. Lapped, Strip Welded Liner—Detail I.



3) Consideration should be given to the use of butt welded strip liners where ferrous alloys are used in high temperature service (above 600° F.), or in such cases where it is necessary that a smooth internal lined surface should be obtained. Concerning the size of the strips, it appears that essentially the same consideration for the width of the strip should be given as was done in handling the spacing of plug welds in plug welded liners. Narrow strips, 3 to 4 inches in width, should be used for high temperature service, whereas wider strips, 6 or 8 inches, or even wider, may be used for low temperature service. The length of the strips is immaterial except from the standpoint of ease of handling and of installation.

Since these tests were made, a number of installations have been made using the strip welded method. Where the liner has been monel or other non-ferrous metal, the lapped strip method has been employed to prevent carbon pickup in the exposed weld. When using 18-8 chrome nickel liner material, the strips have been butt welded together, simultaneous with welding to the vessel wall. The difference between non-ferrous and ferrous metals seems to lie in the fact that the non-ferrous have no iron to start with, and any pickup is 100 percent contamination. On the other hand, ferrous alloys contain a large percentage of iron initially, and it is felt that the addition of a small amount through pickup from the carbon steel shell would have little or no detrimental effect on the corrosion resistance. In addition, a higher alloy rod is normally used for welding ferrous strips, so that it would be expected that the resulting weld have corrosion resisting properties exceeding those of the liner material.

One of the most recent methods of attaching liners to vessels which have been investigated involved the use of stud welding. Here the liner was backed up against the interior shell wall and a threaded stud in an insulated ferrule was pushed through a hole drilled in the vessel wall and welded on contact to the outer surface of the liner. This operation was facilitated by the use of a patented "gun" which held the stud and applied the current at the proper time. After the stud was welded to the liner, a nut and washer combination was used to draw the liner into firm support. See detail in **Figure 17.** Attachment of liners to drums and large pipe by stud welding would seem to have certain advantages over other methods presently used. The material of which the vessel is constructed does not limit the selection of a liner material. It has been suggested that a wooden barrel might



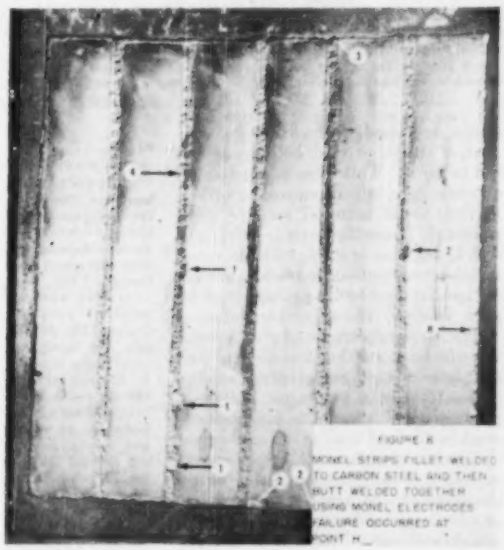


FIGURE 8
MONEL STRIPS FILLET WELDED TO CARBON STEEL AND THEN BUTT WELDED TOGETHER USING MONEL ELECTRODES. FAILURE OCCURRED AT POINT H.

Figure 7. Monel plug welded to carbon steel base plate using monel electrodes. This test specimen was prepared as noted for Figure 1. Four pinhole leaks appeared at 200 psig., marked "1". These leaks were repaired. Rupturing at four welds occurred at 575 psig., indicated by the letter "G". The rupture in each case was at the junction of the weld metal and the monel sheet. Bulging began about 250 psig.

Figure 8. Monel strips fillet welded to carbon steel base plate and then butt welded together using monel electrodes. This test specimen was prepared as noted for Figure 3. Three pinholes, marked "1", appeared at 100 psig. The leaks were welded over. Three more pinhole leaks, marked "2", appeared at 150 psig. These leaks were repaired. Two pinhole leaks occurred, one at 450 psig., and the other at 600 psig., indicated by "3" and "4" respectively. Pressure could still be increased without repairing these two leaks. At 825 psig., rupture occurred at the junction of the weld metal and the monel strip as indicated by the letter "H". Bulging began at 275 psig.

FIGURE 9
MONEL STRIPS LAPPED AND FILLET WELDED TO CARBON STEEL USING MONEL ELECTRODES. UNEXPOSED EDGE INTERMITTENTLY WELDED. FAILURE OCCURRED AT POINT I.

Figure 9. Monel, lapped and fillet welded to a carbon steel base plate, the unexposed edge being intermittently welded to the base plate. Monel electrodes were used. This test specimen was prepared as noted in Figure 6. At 100 psig., a pinhole leak appeared as indicated by "1." The hole was welded over. At 250 psig., all of the tack welds attaching the strips to the base plate broke except in the seam marked "X-X." As the pressure was being brought up after the last tack weld broke two ruptures occurred at a pressure of 225 psig., indicated by the letter "I." The rupture was at the junction of the weld metal and the monel strip. Bulging started at 125 psig.

FIGURE 10
18-8 CR. NI. ALLOY STRIPS LAPPED AND FILLET WELDED TO CARBON STEEL USING 25-20 CR. NI. ELECTRODES. UNEXPOSED EDGE CONTINUOUSLY WELDED. FAILURE OCCURRED AT POINT J.

Figure 10. 18-8 chrome nickel alloy, type 304, strips lapped and fillet welded to a carbon steel base plate, the unexposed edge being continuously filet welded to the base plate. Welding was done with 25-20 chrome nickel electrodes. Five 18-8 chrome nickel alloy strips, 3/32" x 6" x 24" were used. The first strip was placed on a ½" x 30" x 36" carbon steel base plate and the top, bottom, front, and back edges were fillet welded to the base plate. The second strip was placed so that it lapped over the back edge of the first strip and then was fillet welded on all edges. The third, fourth, and fifth strips were installed in the same manner. The carbon steel base plate was drilled and tapped with five ½" holes, located so that one hole was beneath each strip of lining material. A manifold was used to connect the sample plate to the pump so that equal pressure could be applied to all strips simultaneously. At 200 psig., the strips began to bulge. At 270 psig., a pinhole leak occured, indicated by "1." The pinhole was welded over. At 320 psig., the unexposed weld indicated by "X-X" broke loose, and when the pressure again reached 320 psig., about half the unexposed weld indicated by "Y-Y" broke. Seconds later, when the pressure was approximately 320 psig., a rupture occurred, "J," in the weld metal of the exposed seam.

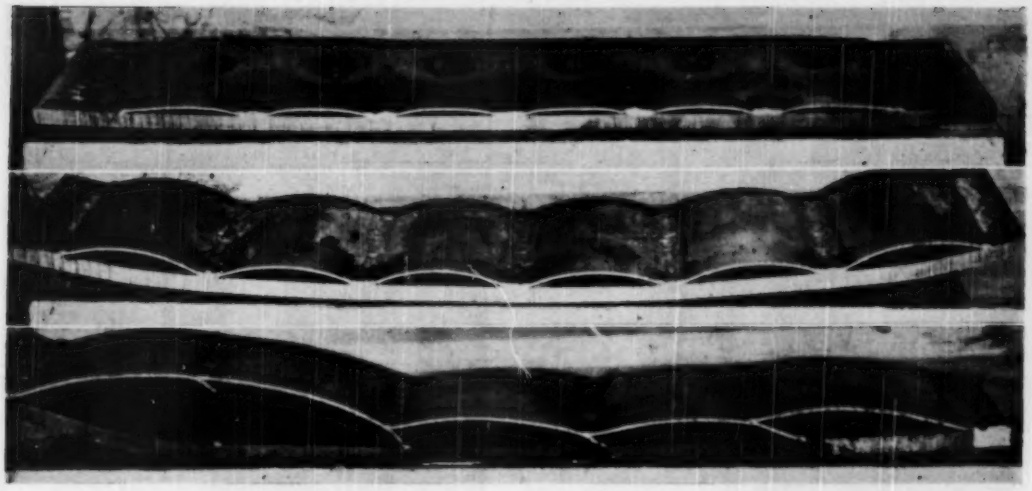
easily be lined with brass by this method should it ever become desirable to do so. While this is cited as an extreme case, other unusual contrasts in liner-vessel material may be more practical. Liners for cast iron vessels, which are exceedingly difficult to attach by conventional methods, present no special problem when attached by stud welding. These initial studies of lining material attached by stud welding also indicate that this method presents the advantages of plug welding without the disadvantages, and it is planned to follow up this experimental work with field tests at an early date.

Specific materials for lining refinery vessels and equipment at Baton Rouge are selected with great care. Corrosion can be retarded by selecting materials which will not corrode at an accelerated rate. The problem of selecting these materials may be complex and frequently each corrosion problem must be treated separately, since there may be little relation between conditions which appear to be quite similar.

The use of corrosion test spools probably offers the most reliable

FIGURE 11
MONEL STRIPS LAPPED AND FILLET WELDED TO CARBON STEEL USING MONEL ELECTRODES. UNEXPOSED EDGE CONTINUOUSLY WELDED. FAILURE OCCURRED AT POINT K.

Figure 11. Monel strips, lapped and fillet welded to a carbon steel base plate, the unexposed edge being continuously welded. Welding was done with monel electrodes. This test specimen was prepared as noted in Figure 10. At 180 psig. the lining material began to bulge. At 220 psig. the unexposed welds broke loose. The seams broke one at a time and as the pressure was brought back up to 220 psig. another seam would break. Rupture occurred at 220 psig. at the junction of two welds and is indicated by "K". The 220 psig. is not a true indication of the failing point of monel as the failure occurred at a junction of two welds where overlap occurred due to faulty welding and was also due to a void that was caused by the grinding wheel used in preparing the sample and that had not been welded over. It is interesting to note that not a single pinhole leak occurred on this test plate.



TOP—Figure 12. Cross-section of Plug Welded Test. Plate Shown in Figure 2. MIDDLE—Figure 13. Cross-section of Strip Welded Test. Plate Shown in Figure 3. BOTTOM—Figure 14. Cross-section of Strip Welded Test. Plate Shown in Figure 10.

method for determining the relative corrosion resistance of materials to corrosive atmospheres and liquids. Detailed recommended practices for such tests are outlined in ASTM Spec. A224-46. It is important that the test spool be located so it is properly exposed to conditions responsible for corrosion. Some factors which must be considered include phases in mixtures of insoluble liquids, velocity effects, turbulence effects, and impingement. The standard recommends the use of two samples of each material for better results, and while this principle is agreed with, it has been found that in most cases space limitations prevent this practice, and generally only one sample of each material is used.

Alloy Liner Materials

18-8 Chrome Nickel Steel

18-8 chrome nickel steel has been used as liner material primarily to combat sulphide corrosion in medium and high temperature service, 550° F. and above. The older liners are mostly AISI type 302. Liners being currently installed are type 304. In some cases of plug welded liners, cracking has occurred around the weld. In every case, it was thought that this cracking was due to a lack of ductility in the area around the weld, aggravated by stresses developed due to differential expansion encountered in high temperature service. The necessary conditions leading to intergranular corrosion of 18-8 chrome nickel steel do not exist in the locations where this material is used in lining service; therefore, it is felt that the advantages of types 304 and 347 over type 302 are partly academic.

Monel

Monel is a natural alloy containing 68 percent nickel and 29 percent copper, and monel liners have been used extensively in overhead equipment and other locations where lower temperatures prevail under conditions which promote chloride and sulphide corrosion. Every precaution is taken to prevent iron pickup in exposed welds made during installation of monel liners. Such liners are installed exclusively by the lapped, strip welded method (method 3, described above) in those cases where clad material cannot be used.

Hastelloy B

Sometimes a combination of erosion and corrosion make the selection of a suitable liner material very difficult. Test data from corrosion spools do not always indicate the service which might be expected, for example, from a centrifugal pump casing. In a particular instance, carbon steel casings had given good service while pumping 98 percent sulphuric acid over an extended period of time. It became necessary to increase the throughput of the pumps, and when this was done, the acid came through the casings in a matter of days. Apparently, the normal protective coating on the carbon steel was being washed off, leaving fresh metal continuously exposed to acid attack. Several liner materials were tried to combat this condition, and Hastelloy B, a nickel-moly-iron alloy, provided the best solution to this problem. Hastelloy B had sufficient resistance to attack by both hydrochloric acid and sulphuric acid as well as the additional necessary quality of toughness and has since been widely used to line acid pumps at Baton Rouge. The method of attachment is welded-in, the liner material being deposited from a Hastelloy B rod.

The use of Hastelloy B plate as liner material has been considered in the Baton Rouge refinery and has actually been used as such by other refineries. This material is readily weldable to carbon steel and should be a lapped, strip welded installation to avoid contamination of the welds. Hastelloy B sheet is felt to have good possibilities as liner material and will undoubtedly be utilized in this service in the future.

Inconel

During the distillation of certain crudes, caustic is injected in relatively large quantities. To protect against possible stress corrosion cracking (or caustic embrittlement) of the steel equipment into which the caustic is injected, Inconel, a nickel-chrome-iron alloy, has been selected as the most desirable lining material. This material is not normally susceptible to stress corrosion cracking, and tests have indicated excellent resistance to sulphide corrosion. Lining with Inconel is usually accomplished utilizing lapped and fillet welded strips as described in Method 5, above, so that the exposed welds are pure Inconel.

Other Liner Materials

In addition to the alloy materials discussed in the preceding action, various metallic and non-metallic liners have found wide application in corro-

FIGURE 15
MONEL STRIPS APPLIED IN MODIFIED FILLET WELD METHOD SEE TEXT FOR DESCRIPTION 4" WIDE STRIPS

FIGURE 16
MONEL STRIPS APPLIED IN MODIFIED FILLET WELD METHOD SEE TEXT FOR DESCRIPTION 6" WIDE STRIPS

Figure 15. Monel strips welded to a carbon steel base plate as described below: Of five monel strips 3/32" x 4" x 24" used, three were individually fillet welded, on all edges, to a ½" x 30" x 30" carbon steel base plate. These three were spaced so that one strip would cover the open space and also lap over the strip on either side a maximum of ½". This strip was then fillet welded to the alloy strips beneath. Ends of the upper strips were welded directly to the carbon steel base. The carbon steel base plate was drilled and tapped with five ½" holes located so that one hole was beneath each strip of lining material. A manifold was used to connect this test plate to a pump so that equal pressure could be simultaneously applied to each strip. A gauge indicated pressure. At 525 psig., the inside seam indicated by "1" failed, allowing the lining material to bulge considerably over this seam, thereby causing a large pressure drop. The inside seam, "2", failed when the pressure reached 425 psig. Consequent bulging again caused a pressure drop. Final failure, "A," occurred at a lapped joint at a pressure of 350 psig. The first expansion of the lining material occurred at a pressure of about 100 psig.

Figure 16. Monel strips welded to a carbon steel base plate as described below: The installation of the monel lining on this test specimen was identical to that noted in Figure 15 except that the strips were 6" wide instead of 4" wide. At 300 psig. the inside seam indicated by "1" broke. The inside seams indicated by "2," "3," and "4" broke one at a time at a pressure of 75 psig. With all four inside seams broken the alloy lining and the base plate bulged excessively, and final failure occurred at point "B" at 60 psig. Apparently the bend due to the excessive bulging considerably weakened the seam. The first apparent expansion of the lining material occurred at 60 psig.

sion control within the Baton Rouge refinery.

Lead

Lead linings are used extensively in sulphuric acid service where concentrations up to 98 percent may be expected. Support of the liner is considered the primary problem and numerous schemes have been devised to effect a proper support. Lead lining of steel plate may be accomplished either by hand bonding narrow strips of lead to the steel or by the mechanical installation of lead in large sheet form. The latter method is favored because of the economics of installation and corrosion resistance. The hand bonding method results in a rough surface which may be undesirable. Some method of installation involving the use of lead covered bolts and structural members is generally used at this refinery. In such vessels as acid reboilers, an inner lining of acid resistant brick helps support the lead lining at elevated temperatures.

The critical temperature for lead liners is considered to be 250° F. Lead tends to reach a plastic state at this temperature, and almost all lead liner failures at Baton Rouge have been attributed to plastic flow at temperatures in this order.

Where vibration is a factor to be considered, experience has shown that tellurium lead can be work hardened and still retain its high corrosion resistance.

Brass

Brass lined vessels as such are not at present used in this refinery. Some brass lined pipe is used where sulfide corrosion at low temperatures is known to occur on carbon steel. Also, numerous brass-lined cocks and valves are employed. Some cast iron valves have welded-in brass trim, applied by brazing. Recently, some experiments have been conducted to determine the feasibility of strip lining carbon steel vessels with brass. In these tests, the strips were lapped and fillet welded, using carbon arc and Everdur rods. Preliminary evaluation of the tests indicate that such liners offer much promise in field service where temperatures below 350° F. prevail.

Glass

Glass has never been extensively used as liner material at the Baton Rouge refinery, although its superior properties as a corrosion resistant material are recognized.

Glass linings have been used in large equipment where a smooth interior surface is necessary to prevent coking or build-up of solids which might adhere to a normal metal surface. When chemical products operations were begun, involving large quantities of acid handling equipment, a considerable quantity of glass lined pipe was used. It was found that glass lined equipment was particularly susceptible to damage when handled by mechanics not accustomed to its fragility. Where damage occurred, field repairs were virtually impossible which made it necessary to make large scale replacements in lieu of repairs. Such equipment has since been replaced by carbon steel piping lined with lead and carbon, together with much brass and copper piping.

Cements

Cements have been used to line ves-

sels and equipment against corrosion and erosion. Hexagon mesh or similar expanded metal is used to support cements. Gunite liners have been installed in naphtha treating drums, hydrogenation coolers, and crude storage tanks. Some difficulty has been encountered when guniting vertical walls of large tanks, it being necessary to employ extreme care during application to prevent subsequent cracking. Tank bottoms present a more practical application for cement lining than vertical walls and here cements are widely used.

In locations where excessive metal loss has been encountered from erosion, cements with expanded metal mesh have proven effective during normal runs and relatively easy to renew during turnarounds. Fluid catalytic cracking operations offer much opportunity to employ this type liner to advantage.

Plastics

The use of plastic paints appears to exhibit some promise in combatting corrosion. In the lower or atmospheric temperature services, these paints seem to have excellent corrosion resistant properties, but thus far their use has been limited due to deficiencies in their application to metal surfaces. Metal surfaces must be scrupulously clean in order to even approach a suitable bond, and the manufacturer's recommendation for application then must be carefully followed for each of the several coats, with adequate drying time for each.

There is a distinct disadvantage to following such a practice in painting refinery equipment during normal turnarounds due to a lack of sufficient time. Also, in the field there exists a very good chance that some areas will not be cleaned thoroughly enough prior to painting and the coating will subsequently fail through lost adhesion in these areas even though it is resistant to corrosive attack. On the other hand, excellent service has been experienced in those cases where plastic paints have been applied in a shop under carefully controlled conditions.

Hot baked phenolic resin paints have been used to line acid pump casings and valves in acid service. Limited service does not allow an accurate evaluation of these liners, but preliminary economic studies appear favorable to this type liner in some acid services.

Vinyl type paints have been used as protection against river water corrosion, acid leaks or spillage, and salt and caustic corrosion. Some vinyl coatings have been external and others internal. Investigation of plastic coatings in field service forms an important part of the refinery-wide paint program. Manufacturers are constantly improving their product while company and contract painters are recognizing that plastic paints require special technique during application. This combination may well lead to more general use of this type coating in corrosion resistant service.

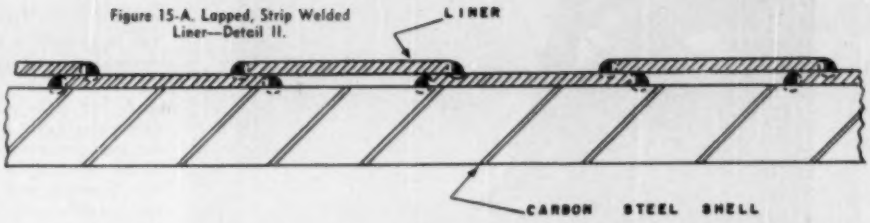


Figure 15-A. Lapped, Strip Welded Liner—Detail II.

Conclusions

In conclusion, ten main points may be summarized:

1) The service factor of refinery equipment subject to corrosive attack will bear close study, as downtime resulting from equipment failure may prove much more costly than the expense of lining such equipment against the attack of corrosive fluids.

2) Strip welded liners present considerable economy over plug welded liners as regards ease of installation and quality of over-all welding, as well as being easier to maintain and repair once the liner is in service.

3) Ferrous strip liners may be butt welded, but non-ferrous strips should overlap on one or both edges so that exposed welds will remain uncontaminated by carbon steel pickup from the base metal.

4) Temperatures encountered in service determine the width of strips to be used. Relatively wide strips, perhaps 6 to 8 inches, may be used in low temperature service, but as temperatures increase, progressively narrow strips should be considered with probably a 2-inch width for 18-8 chrome nickel steel above 800° F.

5) 18-8 chrome nickel steel has been used to combat sulphide corrosion at high temperatures; at low and medium temperatures, monel liners have been satisfactory in this service, as well as for services where chloride corrosion is known to exist.

6) Inconel is being used to combat both general corrosion and stress corrosion cracking at caustic injection points in crude processing units.

7. Test exposure of corrosion spools in the process streams involved is felt to be the most satisfactory method of selecting liner material for refinery vessels and equipment.

8) Glass lined equipment presents an unsatisfactory maintenance problem unless special handling techniques are employed.

9) Hastelloy B has given good service in acid pump casings as a welded-in, or deposited metal, liner. Hastelloy B sheet offers good possibilities as strip liner material in hydrochloric acid and sulphuric acid service.

10) Plastic coatings offer much promise as corrosion resistant liners in atmospheric temperature service. The importance of proper surface preparation cannot be too greatly emphasized, and every effort should be made to follow the manufacturers' recommendations for application of the coatings. These conditions are more easily met under shop conditions than in the field.

Corrosion in the petroleum industry is becoming more and more acute, and it will be advantageous to devise unique methods to extend the life of operating equipment. Higher operating pressures and temperatures foretell new and cheaper methods for processing crudes which tend to become more salty and sour, and place upon the mechanical engineer the responsibility of designing suitable vessels and attendant equipment to contain these hot corrosive fluids.

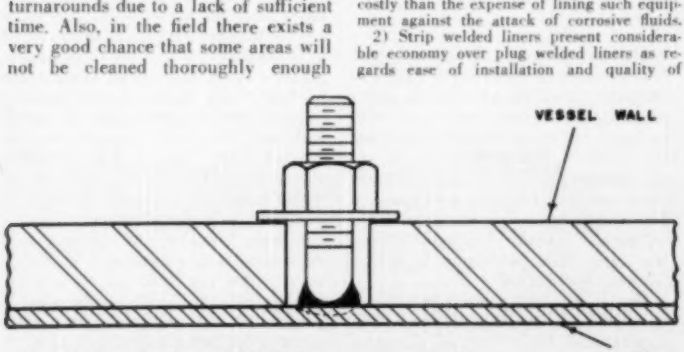


Figure 17. Liner Attached by Stud Welding.

ACKNOWLEDGMENTS

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Hortonspheres for Storing Ethylene, Imperial Chemical Industries' Wilton Works
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Petrochemicals Play Big Part In U.K. Industrial Progress

V. S. SWAMINATHAN
London

IN BRITAIN chemical companies are taking a leading part in the development of the new petrochemicals industry. Major petrochemical plants under construction, or planned, in Britain, and companies responsible for their operation are British Petroleum Chemicals, Grangemouth, Scotland, jointly owned by the Anglo-Iranian Oil Company Ltd. and Distillers Company Ltd.; Imperial Chemical Industries at Wilton; Petrochemicals at Partington near Manchester and Shell at Stanlow. A further recent development is the formation of Forth Chemicals by British Petroleum Chemicals and Monsanto Chemicals for the manufacture of monomeric styrene for use in plastics industries. Before all these developments the British Celanese Company installed a cracking plant, primarily for the provision of some of the basic materials required for their new products, which has been in operation for a number of years. Acetone and acetic anhydride for cellulose acetate have presumably accounted for the largest volume of organic chemicals made from petroleum in British Celanese operations.

The I. C. I.'s postwar expansion plans call for an estimated capital expenditure of $225 million, of which $62.5 million are allocated to the first stage of Wilton works. When the I. C. I. bought a 2000-acre tract on which to erect Wilton works its object was to provide a site capable of accommodating a large part of the company's future developments. These include not only additional plant for products already well established, but the manufacture in quantity of some of the newer items emerging from recent research and development work and possibly completely new manufactures which may arise out of further research. The present program represents merely the first stage of development at Wilton and the works has been so designed that further plants may be added.

At present two plants are in operation at Wilton, one producing perspex sheet from methyl metacrylate monomer made at Billingham on the opposite bank of the River Tees, and the other manufacturing phenolic moulding powder. Construction is in progress on plants to produce Alkathene, the I. C. I. brand of polythene, ethylene oxide, ethylene glycol, formaldehyde, *a*-naphthylamine, urea formaldehyde, mounding powders, Lissapol N, the I. C. I. non-ionic detergent made by the condensation of ethylene oxide and alkylated tar acid.

The Wilton catalytic cracker, in some respects complementary to the Billingham plant for the hydrogenation of such materials as creosote oil, is the means by which the company is entering the petroleum industry. The M. W. Kellogg Company designed and constructed the plant. The initial objective is to work up only the C_2 stream (ethylene), the others being piped to Billingham for working up there. The methane and hydrogen will, for a start, be employed to replace, in part, water gas made from coke used for hydrogen production. The C_3 stream (propylene) will be worked up to isopropyl alcohol and then to acetone, for which the company has a substantial demand. The C_4 stream (butane) will be partly sold as bottled gas, or blended with gasoline produced at Billingham, as will the considerable gasoline from the cracker. The amount of heavy oils made in the cracking process will be comparatively small and used for fuel purposes for the cracker itself. Part of Wilton's ethylene will go to the polythene plant, where it will be subjected to the high-pressure process discovered by the company. Some of the ethylene will be sent by tanker to other I. C. I. factories. The rest will go to a plant making ethylene oxide by the already established chlorohydrin route, some of the oxide being hydrolysed to ethylene glycol for the domestic anti-freeze market. The rest of the oxide will be worked up to Lissopol N, by conden-

sation with an alkylated tar acid made at Billingham. A third plastics division starting operations next year will manufacture urea formaldehyde moulding powders.

The I. C. I. is already looking toward several specific enterprises which will probably lead to new plants at Wilton. Among these are the development of new chemical outlets for C_3 and C_4 streams from the cracker; extraction of various pure aromatics from the gasoline stream of the cracker; development of additional ethylene oxide derivatives and the working up of a propylene oxide-propylene glycol process analogous to the ethylene oxide process; development of other processes to take advantage of the simultaneous availability of chlorine and organics from the cracker and development of fibres other than nylon, like terylene a promising textile derived from terephthalic acid.

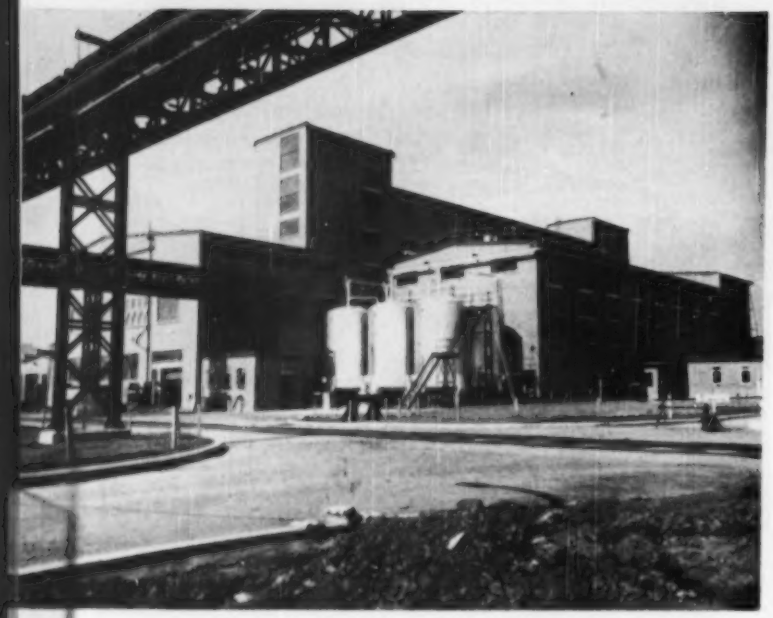
Wilton was chosen for this $62.5 million undertaking because plenty of coal, salt and fresh water supplies are available. There is, too, an ample reservoir of population from which to recruit workers, and there is enough room to house them. Wilton enjoys excellent road and rail communications, while the River Tees has facilities for vessels from small coasters to the largest size ocean-going cargo liners. A special wharf is being built by the Tees Conservancy Commission for use of ocean-going tankers.

Hundreds of tons of crude oil a day will be cracked to obtain hydrocarbon gases from which the more complex organic chemicals are built up. For the present the two most important of these gases are ethylene and propylene. From the former Wilton will make polythene, detergents and anti-freeze. From the latter will be derived acetone widely used as a paint solvent and which also forms one of the raw materials for perspex. Production of acetone will be carried out at Billingham on the opposite bank of the Tees, the Wilton propylene being sent there by 10 mile pipeline which passes under the River Tees through a tunnel 1750 feet long and nine feet in diameter. This Billingham-Wilton link will carry to Billingham various other hydrocarbons produced in the oil-cracking plant and also the gasoline formed as a by-product in the cracking process. In the reverse direction will flow brine from the South Durham brine field forming the raw material for the electrolytic plant producing chlorine and caustic soda. Hydrogen gas is formed as a byproduct of chlorine manufacture. The bulk of it will be sent through this link to Billingham, but part will be retained at Wilton for use in the production by an improved process of alpha naphthylamine for the dyestuffs industry.

All the processes at Wilton are carried out at fairly high temperatures

A Main Intersection of Communications, I.C.I. Wilton Works

Another View of Imperial Chemical Industries Ltd.'s Wilton Works.



Phenolic Moulding Powder Plant, I.C.I. Wilton Works.

and some at very high pressures. Large quantities of steam are used for heating raw materials to the required temperatures, and although a good deal of this heat is recovered, much water is employed in removing the rest of it. Electricity is needed for driving the motors of the compressors, pumps and other machinery used in the plants. A large amount of such power will also be utilized in the plant electrolyzing brine for producing chlorine and caustic soda. Gas is required for heating in some of the processes, for heat treatment furnaces in the workshops and other purposes. When the present stage of development is completed it is reckoned that about 500 tons of coal will be used daily in the boiler house, and steam raised at a pressure of 900 psi. Before being sent out into the network of pipes feeding steam to the plants this steam will be passed through turbo-alternators which will generate the bulk of the 30,000 kw required for production. The North-East Electricity Board will meet the remainder of electricity needs.

For cooling purposes arrangements have been made by the Tees Valley Water Board to furnish 42 million gallons a week of water from the River Tees at Low Worsall and piped to Wilton works' 6-million-gallon reservoir through 13 miles of main. Other water requirements will total nearly 5 million gallons a week of purified water from the same Board mainly for the boilers. Gas comes from the Northern Gas Board, and a main is being laid from the works of the Board's Middlesbrough Division.

An extensive road and rail system is being constructed, including more than 10 miles of roads and 15 miles of railways. The lines to Wilton will branch off from the main line about a mile from Grangetown, and the British Railways have constructed bridges under the Middlesbrough-Saltburn line. Through the latter will pass the railway lines into the works and also the drainage culvert. All the drains lead eventually into a main drainage culvert of 7 feet diameter reaching the foreshore at Bran Sands. This large culvert can cope with a flow of 90 million gallons per day.

The workshops and main store were the first buildings to be erected. The canteens and change rooms are up to the most modern I. C. I. standards. The designers of Wilton works have striven to provide clean and pleasant surroundings for those who work there. A 300-foot chimney with electrostatic precipitators and cyclones for cleaning waste gases will do much to abate atmospheric pollution.

In fact, the I. C. I. Wilton works are giving a lead to British industry in the matter of getting rid of obsolescence, and of promptly applying results of scientific research to commercial production. So far nearly two-fifths of the work for the above plants and services has been completed.

Across the Tees Billingham's most spectacular pre-war expansion was the great hydrogenation plant opened in 1937 for the production of upwards of 100,000 long tons of gasoline annually. It was the natural site for the project because of its situation, technical resources and the unequalled experience of its personnel. It attained full production in 1939, and helped supply Royal Air Force and other war requirements. Hydrogenation involves very high pressures and temperatures, and consists of adding hydrogen (obtained from 'H' gas) to imported creosote oil. This is effected in converters at a temperature of 400-450° C. and a pressure of 250 atmospheres. The oil so produced is similar to crude petroleum and has to be refined. A large section of the plant therefore consists of distillation equipment.

The process gives rise to a number of valuable byproducts, particularly tar acids, which are shipped for use in the manufacture of plastics, disinfectants, dyestuffs and medicinal chemicals. Perhaps the most interesting feature of the hydrogenation process is its flexibility. Any grade of gasoline can be made.

The Billingham works is the largest chemical undertaking in the British Empire and the second largest in the world. It occupies a site of about a thousand acres on the north bank of the River Tees and is seven miles in circumference. The annual total is 1,250,000 tons of products vital to national economy, ranging from fertilizers to high-grade gasoline. The Billingham-Wilton setup is expected to be the world's largest chemical unit.

Turning to other petrochemical undertakings, Shell's Stanlow plant started operations last July. It is a thermal cracking unit with other equipment specially designed to deal with cracked products. The basic material is gasoil from which is obtained a high proportion of olefins, propylene and butylene which when separated form feed-stocks for the manufacture of solvents and other chemicals.

Stanlow comprises a chemical plant with an annual capacity of 24,000 tons of solvents, and a plant manufacturing detergents with a current capacity of 50,000 tons a year, which is shortly to be raised to 75,000 tons.

The Partington plant of Petrochemicals Company near Manchester employs the Catarole process by which aromatic compounds and olefinic gases are produced simultaneously from a crude oil fraction. Initial annual capacity of 75,000 to 100,000 tons may be considerably expanded later.

Thus petrochemicals are already playing a significant part in the industrial progress of the United Kingdom.

Liquid-Phase Hydrogen Sulfide Removal

L. W. ZAHNSTECHER
Process Engineer, Petroleum Division, Foster Wheeler Corporation
New York

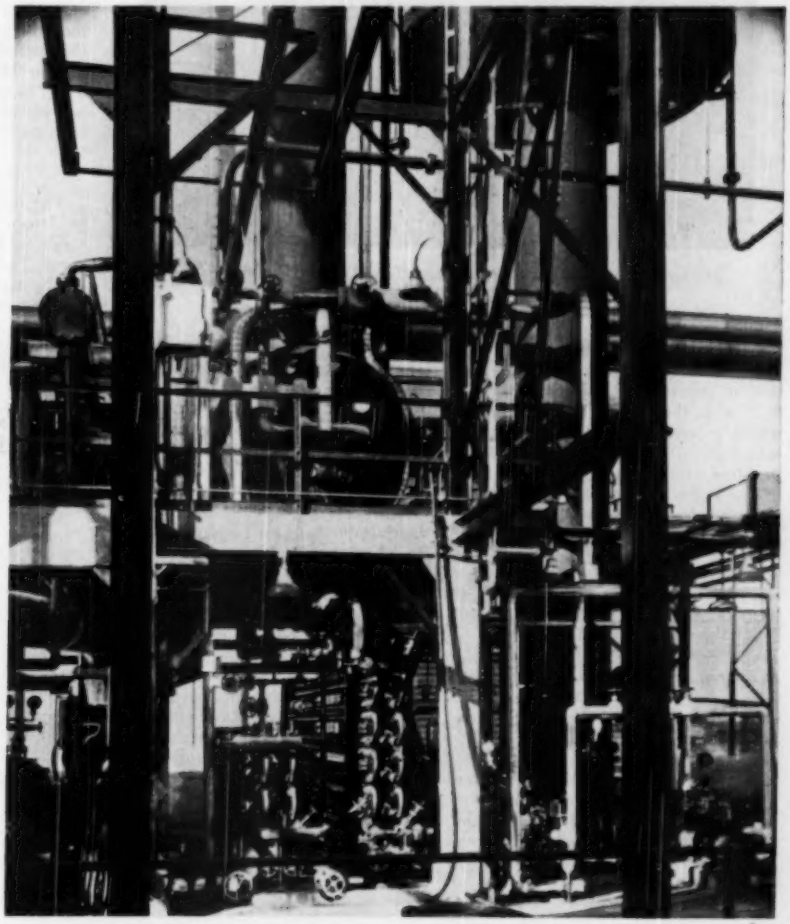
***THE TREATING** of liquid feeds to catalytic polymerization units presents a number of problems. There are, however, a variety of answers that are more-or-less attractive. The best choice depends upon the volume and purity of feed stock, and other factors. In this plant the use of a liquid phase extraction system for the removal of H_2S by means of a regenerative type solution was selected as the optimum.*

MID-CONTINENT Petroleum Corporation has recently installed a regenerative type hydrogen sulfide removal unit to treat 4300 barrels per stream day of liquid phase poly plant charge containing 300 grains of H_2S per 100 standard cubic feet (scf) and one percent carbon dioxide by volume.

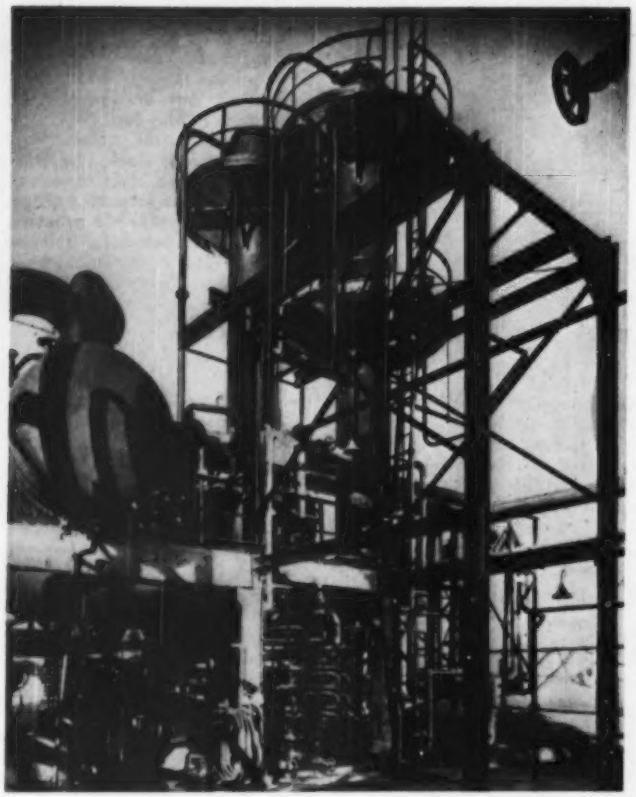
The H_2S removal method chosen was a tripotassium phosphate process (patented by Shell Development Company) designed and engineered by Foster Wheeler Corporation and erected by Mid-Continent personnel.

Reasons for H_2S Removal

The catalytic polymerization plant takes a cut consisting of propane-propylene and butane-butylene (designated as C_3-C_4) as the liquid overhead product from a large gasoline debu-



Close-Up View of Unit, Showing Reboiler and Stripper in Center, with Stripper Overhead Condenser at Left and Extraction Column at Right.



Another View of the Extraction and Stripping Towers, with After Settling Drum at Left and Fin Tube Exchangers in the Foreground.

tanizer. Hydrogen sulfide in the poly plant must be kept at a low concentration to prevent the polymerization of H_2S with the olefins in the charge, which produces objectionable mercaptans and sulfides in the polymerized gasoline product.

The H_2S in this charge was formerly removed by a single-stage caustic scrubber of the mixer-settler type. The use of a single-stage caustic scrubber was justified when the charge to this catalytic polymerization unit was smaller and less contaminated with H_2S. However, with the increase of liquid C_3-C_4 stream to 4800 bpsd., the hydrogen sulfide at 300 grains per 100 scf., and a high CO_2 content, the caustic consumption became unreasonably expensive.

A number of methods of economizing on caustic were open to the operating company. A more efficient use of caustic may be obtained by the installation of multiple-stage countercurrent washing. The original single-stage contact utilized 50 to 60 percent of the caustic. Multiple-stage washing, whether in mixer-settlers, packed tower, or perforated-plate tower, may increase this utilization to 90 or 95 percent.

Another method of conserving caustic is the use of multiple-stage countercurrent water prewash. Recently published data[4] on water washing, however, indicates a large consumption of water, large contacting equipment, plus the additional problem of disposal of the waste sulfide-laden water.

Tripotassium Phosphate Process

A third method, the one chosen by Mid-Continent, was the liquid-phase extraction of H_2S by means of a regenerative type solution. Possible solutions include organic solutions such as aqueous amines, and salt solutions such as tripotassium phosphate. The mechanical equipment for the two is very similar. However, for poly plant feeds, the salt solution has the advantage of being nonvolatile, and nonsoluble in the hydrocarbon feed. In the salt-solution process the hydrocarbon will not carry over any ammonia or ammoniacal compounds into the poly plant unit that will poison the catalyst.

The tripotassium phosphate process also has the advantage of being selective to the H_2S when desulfurizing a hydrocarbon charge of high CO_2 content. This factor makes for a more economical unit, since the solution circulation rate and steam consumption is only fractionally higher than for the H_2S alone.

The process flow is illustrated schematically in the flow diagram given in Figure 1. Hydrocarbon charge at 300 psi. and 100 F. enters the base of the extractor and flows up countercurrent to a descending stream of tripotassium phosphate. The extractor tower is three feet in diameter and is packed with one-inch stoneware Raschig rings to a height of 30 feet.

The phosphate solution forms the continuous phase, and liquid hydrocarbon rises through the solution, coming in intimate contact with the tripotassium phosphate. A liquid-level controller above the packing controls the flow of phosphate solution out of the bottom of the tower. The upper section of the tower is enlarged in order to minimize the entrainment and carry-over of solution with the hydrocarbons.

Coalescing Section

The upper settling zone contains a coalescer in the form of metal textile mesh, which helps to prevent entrainment. The use of a coalescing section at the top of the tower helps reduce the cost of the unit by eliminating the need for an extra knockout drum with its attendant piping, control instruments, pumps, etc. The hydrocarbon free of H_2S leaves the top of the tower and enters the water wash facilities (to maintain moisture of the calatyst), and thence goes to the poly plant.

Lean tripotassium phosphate solution enters the top of the extractor just above the packing and flows downward against the rising hydrocarbon stream, extracting the hydrogen sulfide. After passing through the packing the solution, now rich in H_2S, leaves the bottom of the extractor under its own pressure and is heated in a series of double-pipe exchangers. The heated rich solution enters the top of a bubble tray stripper, which contains ten trays and is two feet six inches in diameter.

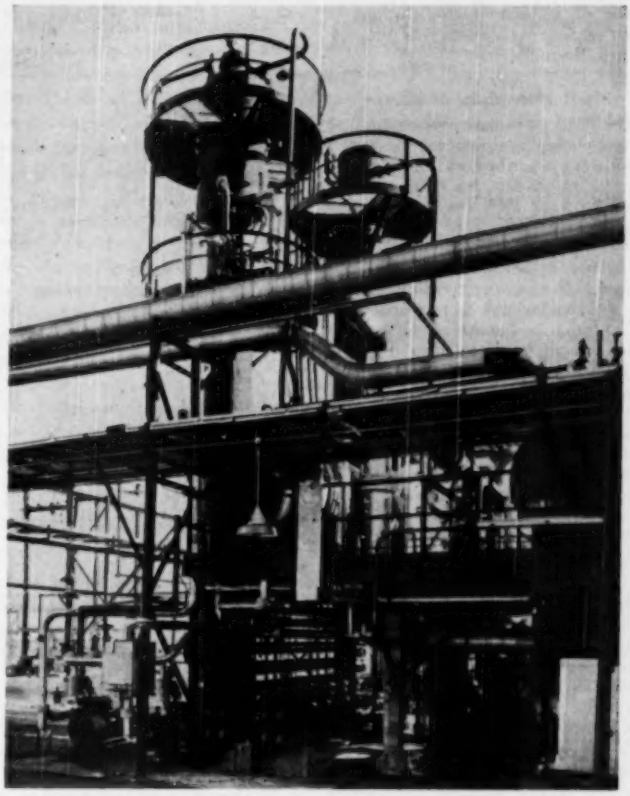
The solution descends through the stripper, coming in contact with ascending steam, which strips the hydrogen sulfide in the rich solution. The solution then drops from the stripper to a regenerative surge drum, where the partially stripped solution is boiled up, completing the scrubbing of H_2S from the solution. The lean

solution leaves the regenerator and is partially cooled by exchange with the stripper feed. The solution is then pumped from atmospheric pressure to 300 psi., and after further cooling with water in double-pipe exchangers it enters the top of the extractor to complete the solution cycle.

Low-pressure steam exhausting from the reciprocating pumps plus a small amount of live make-up steam is used in the reboiler tube bundle. Open exhaust steam may be used, but in that case the condensate is wasted and a problem arises as to the disposal of the H_2S laden condensate. Steam formed in the regenerator surge drum by boiling the solution rises in the stripper and carries the H_2S with it. The stripper operates at substantially atmospheric pressure, since any increase in pressure makes stripping more difficult and increases steam consumption.

Condenser Section

The steam together with the H_2S passes overhead from the stripper to a condenser where the steam is condensed. The H_2S leaves from a vent on the upper part of the condenser and is led to a furnace where the H_2S is burned. Condensate passes back through the condenser and flows down through the outer portion of an annulus which is concentric with the inlet steam pipe. The object of this arrangement is to reheat the condensate so that the equilibrium H_2S dissolved in the condensate will be a minimum. The condensate drops from the con-



4800 BPSP Liquid-Phase Tripotassium Phosphate H_2S Extraction Unit, Showing, Left to Right, the Circulating Pump, Main Extractor Column, Heat Exchangers, and Stripping Tower.

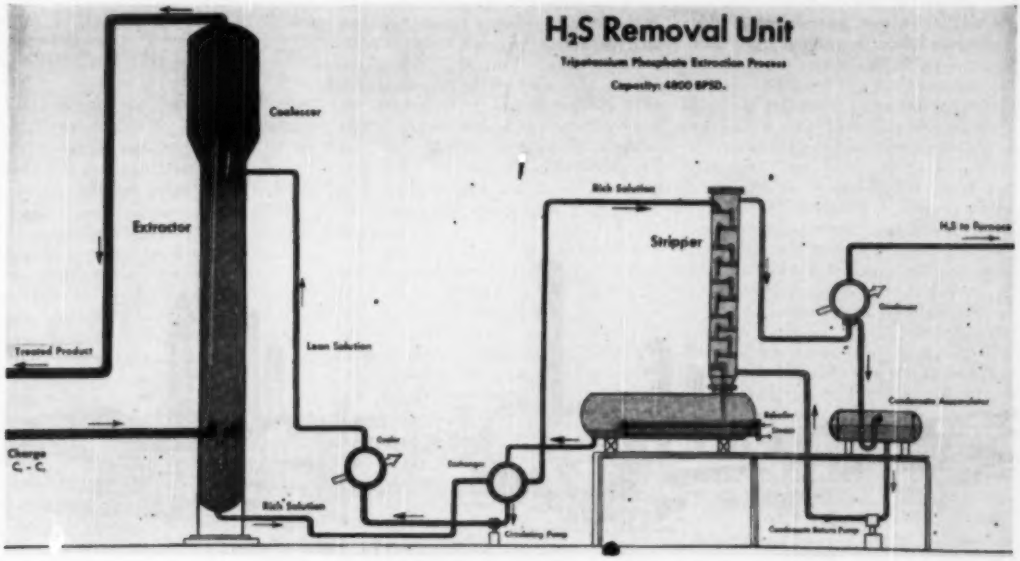


Figure 1

denser to an accumulator through a water sealing leg, whence it is pumped back to the stripper.

Shell Phosphate Process

The Shell phosphate process applied to gas-phase H_2S removal has been adequately described by others.[1,2,3,5,6] Briefly, the process for either gas- or liquid-phase H_2S removal depends upon the reaction

$$H_2S + K_3PO_4 \rightleftharpoons K_2HPO_4 + KHS.$$

Tripotassium phosphate solution can absorb H_2S at temperatures up to 200° F., and the reaction is reversed when the solution is heated to the boiling point—about 235° F. at 5 psi. The solution of tripotassium phosphate is made up by mixing the proper quantities of potassium hydroxide and phosphoric acid in an approximate mol ratio of 3:1. The mixture is a stable inorganic salt solution having a specific gravity of up to 1.5, and is easily handled, nonpoisonous, nonvolatile, noncorrosive, and noninflammable.

Process Requirements

In general, the process requirement involved in the optimum design and operation may be divided into three groups: 1) the plant constants, 2) the design variables, and 3) the operating variables. The variables of each group are listed below:

1) The basic operating plant constants comprise the specifications for a given treating problem and include the following:

a. H_2S content of charge.
b. CO_2 content of charge.
c. Extraction temperature.
d. H_2S content specified in the treated hydrocarbon.

TABLE 1

	Operating Data	Basis of Design
A. Flows:		
Poly plant charge, bpd.	4600	4800
Solution circulation, gpm.	25	25
Steam, lbs. per hour	2200	2100
B. Pressures:		
Absorber C-1, psi.	395	350
Regenerator T-3	2.5	5
C. Temperatures, °F.:		
Absorber bottoms C-1	79	100
Regenerator	226	235
H_2S disposal	95	125
Lean solution to absorber C-1	82	100

TABLE 2

	Lean Solution	Rich Solution
H_2S molality	0.13	0.26
RSH (mercaptans) molality	0.00	0.02
Specific gravity at 60° F.	1.354	1.344
Ratio, K/PO_4	2.97	3.01
Ratio, H_2S/PO_4	0.090	0.187
Ratio, CO_2/PO_4	0.493	0.640

Charge to treating unit	CO_2—0.50% by volume
	H_2S—250 gr/100 scf.
	Other S— 2 gr/100 scf.
Treating unit effluent	H_2S—1.7 gr/100 scf.
	RSH—1.7 gr/100 scf.
	Other S—0.9 gr/100 scf.
	Total S—4.3 gr/100 scf.

e. Hydrocarbon capacity of the unit.

2) The basic design variables are those design factors that are based upon the first group of constants. They include:

a. K_3PO_4 concentration of solution.
b. Mol ratio of KOH to H_3PO_4 in solution.
c. The number of stages in the extraction unit.

3) Operating variables include the following:

a. Stripping steam rate.
b. Sulfide content of solution.
c. Flow rate of solution.

The actual operating conditions are given in Table 1.

Table 2 summarizes certain process data for lean and rich solutions, charge to treating unit, and treating unit effluent.

The mechanical operation of the unit is quite simple and requires very little attention, taking only a small amount of extra time on the part of an operator already assigned to the catalystic polymerization unit.

Contract for the above job was let in March, 1949, and hydrocarbon circulation started on October 5, 1949. The speed of construction was due in large measure to the excellent engineering shop force of Mid-Continent Petroleum Corporation who erected this unit.

The removal of hydrogen sulfide from liquid-phase hydrocarbons by means of regenerative tripotassium phosphate is also applicable to gas-phase H_2S removal. A new application of this process is the selective removal of H_2S from a gas containing a high CO_2 content.

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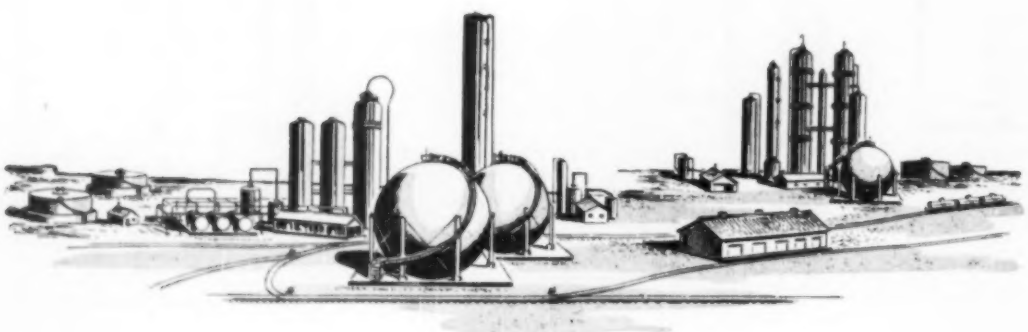

SOME PREMIUM motor gasolines now reach 92-93 research octane number, and 95 octane fuels may become fairly general in the not to distant future. Current activity in our automotive industry, however, involves the development of engines that are eventually expected to operate at compression ratios of the order of 12.5 to 1. Another 15 octane numbers would be required to care for 12.5:1 C.R. in any production engine that has so far been tested.

Recent studies indicate that the cost to the oil industry as a whole for 10 additional octane numbers obtained by refining methods would be some 2 to 3 billion dollars, while an equivalent reduction in octane demand on the part of the engines could be achieved at a cost of 300 to 500 million dollars for the automotive industry. Also, less motor fuel can be realized per barrel of crude at the higher octane level. Obviously, every effort must be made to develop engine designs that incorporate the fuel consumption advantages of high compression ratios and yet make the minimum demand for octane numbers. This article, presented at the API Lubrication Committee meeting held in Detroit in June, discusses some of the measures that can be followed in lowering the octane number requirements of gasoline engines.

Compression Ratio, Octane Demand and Lubrication

R. J. S. PIGOTT
Gulf Research & Development Company, Pittsburgh

IT IS evident that the desire for higher specific output and better economy will continue the drive for higher compression ratio. Judging from earlier work, done manly on racing engines, compression ratio is not likely to go higher than 13:1 or perhaps 14:1, because at these compression ratios difficulty with strangulation of the valves may cancel out the possible gains in brake mean effective pressure (bmep) and efficiency. In addition, the gain from higher compression ratio is flattened out so much as to approach the vanishing point.

Factors Involved in Detonation

The temperature at the end of compression, whatever may be the cause, is probably the principal agent inducing detonation. Naturally this temperature is modified by local temperatures, higher than the average, and their relation to the flame front. Density has some effect, without doubt, but not nearly as important as temperature. The principal factors that can influence temperature at the end of compression are about as follows:

1) Compression ratio; 2) turbulence; 3) intake temperature of mixture; 4) effectiveness of jacketing, especially the head; 5) imperfectly cooled reentrant corners that appear in most of the L-head designs; 6) hot exhaust valves; 7) piston head temperatures; 8) residual gases and 9) manifold distribution.

Compression pressure goes up as the 1.35 power of compression ratio; absolute temperature goes up as the 0.26 power of compression ratio. These values differ from true adiabatic, from the effects of jacket cooling and hot parts.

Turbulence, chiefly by the higher heat transfer due to higher velocity over the jacket surfaces, tends to reduce the end temperature of the charge especially when a quench area is used.

Intake temperature is generally a compromise for the natural induction engine; on the one hand to reduce final compression temperature it is desirable to hold intake temperature down; on the other, starting, warm-up and good gasoline vaporization need higher temperatures. In the case of supercharged engines it is possible to accomplish a considerable amount of cooling by the introduction of a cooler after the supercharger, without spoiling the vaporization. Where compression is two-stage, as in supercharging, this intermediate cooling can have a very pronounced effect on the octane demand of the engine. One example of which we have rather full knowledge is a racing engine of 13.5 c.r. (compression ratio) overall, operating on 82 ASTM, 83 Research octane without detonation. The drop in temperature provided gave the equivalent of 8:1 c.r. temperature, approximately. The rest of the reduction in octane demand was due to the high speed, and an especially well-cooled cylinder barrel and head—a very thin steel sleeve for the barrel and aluminum head being employed.

Much better jacketing and head cooling passages can be made. There have been many designs on the market in which boiling was occurring in the jacket, usually near and around the exhaust valve connection. There has never been any excuse for boiling in the jackets because it is kown to be true that any liquid normally used for cooling (i.e., water and water-glycol mixtures) can take away far more heat per square inch of transfer surface than any gas can bring to the other side; consequently, the boiling has always been the result of undirected flow and velocities much too low. In other heat transfer apparatus we do not consider velocities of much less than 5 fps., in many cases carried up over 7 fps. No such condition has ever existed in the jacket of the ordinary engine designs. In many cases the velocities are so low as to result in viscous flow, consequently very uneven cooling and striation.

The major reason jackets have not been better designed is due to cores being made sturdy enough to keep rejects in the foundry under control, and to failure to calculate the flow path conditions.

The hot exhaust valve effect can be largely canceled out by the position from which the ignition is started. The remaining unfired charge will be away from the exhaust valve where it can be reasonably cooled, but obviously the effect of the exhaust valve in heating the total charge cannot be eliminated.

Ever since internal combustion engines have been produced, we have been generally using uncooled pistons and are still using them for most designs today. With piston temperatures

likely to go up, in the heavy duty designs particularly, we should be giving serious consideration to liquid piston cooling. The advantages would be considerable; certainly lubrication could be improved and ring-belt temperature reduced. In addition, if quench areas are used for the last portion of the charge to fire, a cooled piston could assist this situation greatly; an uncooled piston furnishes up to 50 percent hot area in the so-called quench region.

So far as the effect of residual gases is concerned, higher compression ratio by itself tends to reduce this effect by reducing the quantity.

The manifolds have an influence on the picture because due to striation a manifold can produce one or more cylinders at leaner mixtures than average and these are usually the ones at which detonation will first appear. Manifold design, it would appear, is still not in a very good state. There are many designs of manifold on the market that look like a basket of worms. The cause of manifold pressure loss is not so much skin friction, but largely elbows. The elbows not only produce considerable drop but also encourage striation of gasoline into rich and lean mixtures. In the racing car designs, especially those of Harry Miller, considerable attention has usually been paid to eliminate as many elbows from the manifolds as possible. One design, I think proposed by Barney Roos back in 1917 or 1918 for Locomobile, Jr. 8, had only two elbows in series from carburetor to valve. This was accomplished by putting the carburetor at one end of the manifold, one branch elbow and one elbow at the valve. This design was not adopted as it appeared too radical. The old Franklin trombone manifold was also good in this respect in that it allowed three elbows up to the valve and gave a two-path flow which tended to average out striation effects. Another design, I believe tried out by White, was a good deal like a spider crab; each branch to the cylinder had the same length and number of elbows. Distribution, it is understood, was good in this manifold.

We are interested to reduce total pressure drop, to keep up volumetric efficiency, and to reduce striation as far as possible, in the interests of wiping out the lean cylinders.

Other Designs Than Poppet Valve

Most of us are familiar with the designs that have been offered in the past 30 years; Alex Taub has recently published a number of articles discussing them.

We all remember the original Knight two-sleeve design as employed in the Stearns-Knight and Willys-Knight. These engines were undoubtedly more expensive to make than the poppet valve, but part of this difference in cost may have been due to the small quantity produced, which is a major factor. The two sleeve design is difficult to lubricate properly and still hold down the oil consumption. In addition, the interior of the cylinder on which the piston and rings run is definitely hotter, due to interposition of several joints between the jacket and the piston. It is, however, quite true the octane demand of these engines was definitely down below that of the poppet valve engines in use at the same time.

Use of Argyle Design

The Argyle single sleeve, it has been claimed, is more expensive than the poppet valve, although if produced in quantity, this does not seem to be necessarily true. This design has seen a good deal of commercial employment. It is easier to lubricate and control the lubricant than the double sleeve and while the cylinder is hotter so far as the piston and rings are concerned, it is not, of course, as hot as the two sleeve design. An objection to all of the sleeve designs can be urged; due to weight of the sleeves the inertia forces on the valve mechanism may be high and they are not likely to be too good for high speed. In the aviation engines where the Argyle sleeve has been principally employed, the speeds do not exceed 2700. We have, at any rate, some practical experience in this design as exemplified in the Bristol Centaurus, Napier Sabre and Rolls Royce Eagle, all of which were flown in World War II. These engines appear to have an octane demand somewhere in the neighborhood of 12 octanes lower than poppet valve engines for the same general compression ratio.

The Skinner design classes as a single sleeve but actually it is two half sleeves. It is claimed this engine is also expensive to build. Its quality should be, in general, much the same as the Argyle but in addition, the split down the cylinder between the sleeves is not good. The octane demand is lower than the poppet design, and about the same as the Argyle single sleeve engine.

Two designs have been discussed, both of which have been in existence for a considerable period of years, but so far have been built only in experimental models. The Abell single valve design has rather a complex valve gear consisting of a single main valve for both inlet and exhaust and a transfer valve for exchanging these functions on the main valve; this arrangement is rather like the earliest Franklin engine produced 35 to 40 years ago. While the valve gear is complex, it should be feasible, but it looks like it would cost more than the poppet valve. Nobody can be very sure on this point because the engine has never been produced in quantities. The writer's objection to this design is it only goes halfway in the problem of reducing the main hot spot in the cylinder. The single main valve will come to equilibrium at somewhere between the temperature of the inlet and the exhaust valves in the poppet engine; and the hot valve is not the only thing needing correction; and as mentioned above, the effect can be largely canceled out by proper location of the spark plug. This design is said to have an octane demand about 20 octanes lower than the poppet valve design.

The Aspin conical valve, usually termed "rotating combustion chamber," has only been built experimentally and while apparently the valve mechanism could be quite simple, it has a very heavy valve thrust and most of the designs so far have been worked up with a view to support this thrust. It seems to the writer if this design were properly worked out it should be possible to balance the valve. Very likely there will be, along with the balancing, a lubrication problem. The average of the entire interior of the combustion chamber comes down fairly close to the ordinary jacketed wall temperature. The octane value is said to be down 50 points. The writer's guess is no better than anybody else's at this stage, but I would be inclined to feel this design would be somewhat more expensive to build than the poppet valve. It must be noted there would no doubt be quite a good deal of development expense in making this engine durable and trouble-free for production.

"None Satisfactory"

The writer is informed that one motor car manufacturer has gone to very considerable expense in investigating all the preceding designs and so far feels that none of them are satisfactory. I do not feel that this is the final answer because it is true that in many cases new designs have to be carried through by people who are sold on the idea to begin with in order to reach success at all. The oil industry would no doubt be interested in seeing these designs proved up. However, I have no bill of goods to sell for any of these particular variations.

One other group of designs has been occasionally tried. These designs used Corliss type valves, oscillating or rotating. One design ran very well at 6000 rpm. and apparently the de-

signers had found out how to lubricate these valves. I know of no development where this has been brought to practical production, however.

It is obvious both for the risk involved and from increase in retooling costs for new designs that the automotive industry is not likely to take very kindly to radical changes in the engine design, no matter how well propagandized. It is well, therefore, to examine what might be done without a major change in the engine.

Mr. Heron's paper has given us quite a little information on what happens in one or two of the general designs, but even with the mass of material that he has presented to us, it still does not begin to cover the field that must be investigated and proved up.

More than 30 years ago, Cameron first and Ricardo (usually credited with the introduction) second, introduced the horizontal valve type of head, which is something like an F valve arrangement laid on its side. This arrangement allows location of the spark plug so as largely to wipe out the effect of the hot exhaust valve, and in addition, gives more quench area than most other designs. From the position of the valve chamber it is possible to eliminate the badly cooled reentrant sharp corners appearing in the L-head designs. Duesenberg used this design for some of his engines with considerable success, although little is known of any measured value of the octane level requirement.

Mr. Brownback has recently offered some very interesting thoughts on a design exemplified particularly in the Renault models for which he is responsible. He is, it is understood, proposing to use this Cameron-Ricardo construction with horizontal valves, aluminum heads and better jacket design. He states that these designs will reduce octane demand 10 to 12 numbers below the ordinary designs now used, and stands ready to back up his statement by producing the engine and car to be tested.

It is, of course, true that part of the gain he has made might be influenced by the small cylinder sizes with which he has been concerned, but his moves in the direction of lower octane demand are directly along the line which the automotive industry will like better than considering the Aspin, Abell, radial valve or any other radically different design. It is obviously much easier for the automotive industry to improve the present designs than to adopt completely new ones.

Required Octane Demand

The best of the premium gasolines perhaps reaches 92-93 and may shortly become fairly general at 95. It would take 15 additional octane numbers to take care of 12.5:1 c.r. in any production design that has so far been tested; and the house brand gasolines would have to go up about 25 numbers. It should be quite obvious that the oil industry is not going to be able to produce so much increase in chemical octane, and therefore it has got to come, at least in most part, from changes in the engine. It is, of course, not necessary for us in the oil industry to propose any particular design to the automotive people because I think we can safely leave the choice largely in their hands, and they are undoubtedly working on it. In the interest of getting the change made, it is going to be very necessary that the automotive industry should be satisfied that they can continue to make money with the new designs, and that it will not cost them too much to get there.

Cost of Octane Value, Either Chemical or Mechanical

Mr. Ayres' recent studies, checked against material prepared earlier by Mr. Holaday, indicate that to increase ten octane numbers by refining would cost the oil industry as a whole somewhere between $2.5 and $3 billion dollars. To get the equivalent reduction in octane demand on the engines, however, would appear to be something in the order of $300 to $500 million for the automotive industry; in effect, not a great deal more than would be required over the period of change for ordinary new models, since most of the cost of the change-over is going to be tooling in any case.

Details

It seems to be pretty generally established that good conductivity heads, such as aluminum, can lower the octane demand. It is a matter of some surprise that this should be so because most of the heat transfer resistance is on the gas side, not in the liquid film or the metal. Mr. Brownback is using aluminum heads in the Renault engine and states he can prevent corrosion and gasket creep. It would seem likely that some anodizing or heavy plating could prevent corrosion and would eliminate much of the trouble hitherto found with aluminum heads. Such designs must, of course, wind up no more costly than the present heads. However, we might find cast iron quite satisfactory when the cylinder head cooling flow is improved.

It is important we redesign to get a definite jacket flow-path so as to get velocities of 2 to 4 fps. all over the barrel and especially the head; this would produce great improvement in uniform and better cooling, and probably a considerable reduction of distortion. It is for this reason the writer feels the desirability of employing wet sleeves. This has been done before now in relatively cheap engines at low cost.

The advantages of the wet sleeve are that thinner sleeves can be used, machined uniform, and jacket space will no longer be too large from the desire to make cores sturdy; consequently, passage area can be cut down to get velocities up where they belong. Use of the wet sleeve would permit more desirable cylinder material for wear. Again, the use of the wet sleeve gives an opportunity for further reducing distortion and I think we are going to find distortion of cylinders is going to be one of our principal headaches for the future, particularly as the compression ratio and temperature involved go up. Certainly we will have to improve piston sealing and wear for the future, and distortion is one of the troubles.

Lubrication

Recent experiments made at the Laboratory, while not carried very far yet, have indicated pretty plainly that we are getting a coefficient of friction up as high as 0.10 in "satisfactory" operation and 0.15 at scuff, and that we have never yet properly lubricated an assembly of rings. Here again we are in a dilemma. We want good lubrication to keep down friction, and at the same time we want a good seal with no oil pumping; these results are usually not too compatible in the present ring setup. But it is astonishing to find that a piston ring is in metallic contact with the cylinder at all points of the stroke. This definitely means that no proper oil film was established. The coefficient of friction indicates the same thing. When the coefficient of friction is up to 0.10, we are not getting good lubrication. Piston cooling as so far employed in a few designs has been relatively inefficient in reaching the result desired, one of the reasons being that without exception so far the attempt has been made to supply the cooling oil through a drilled rod. Our own experiments have shown quite plainly that this method of oiling, not only of cooling the piston but for oiling the wrist pin, can be extremely risky. In one of the commercial designs on the market, operated at 2000 rpm., relatively short stroke, the inertia forces were such as to overcome the oil supply and induce air into the system, resulting in an irregular supply of lubricant. Calculations against the test results showed the rod was only about half full of oil most

of the time. In other words, the upper end was being lubricated with foam. A similar case was found in a slower speed engine, stroke 26-inches, in which the inertia forces were high enough to produce the same troublesome conditions. We have been able to demonstrate on a laboratory setup that oiling through the rods can be made to give proper supply of oil every stroke, every other stroke, or not at all, depending on the geometry of the system.

The oil supply to the wrist pin will depend on all of the factors involved in the system; i.e., oil supply pressure, resistance of bearings, oil conduits and inertia forces. It, therefore, appears that if we are to do a job on cooling pistons, it should be performed by a separate jet independent of rods, in which continuous supply without inertia forces can be assured and one can easily predict what sort of flow will obtain. It is, of course, obvious that if compression ratio goes up the troubles of the ring belt are apt to increase. If we are not to have appreciably increased lubrication troubles in the ring belt, we must do something about cooling the piston and improving the ring lubrication.

With regard to bearings and gear trains, the situation does not seem to be in any wise different than at present. The bulk of the automotive engines now run at bmep. of 120 psi. average; the four highest, new engines, at 132 average; aviation motors run above 212 psi. Consequently the increase of bmep. by way of increased compression ratio in automotive engines should not add any problems on bearings and gear trains not already met, and for the most part solved.

It appears, therefore, that the two elements that will be affected by increased compression ratio will be the ring belt and the valves. It would appear further that the solution is likely to be almost wholly mechanical (design) and not the lubricant (chemical).

We can, as pointed out, liquid-cool the piston and drop the temperature of both ring belt and crown; and we must find a better design for rings to get the lubricant under the rubbing surface thereof without losing oil-control. Both these paths are wholly matters of design. We must cool the valve stems better, and perhaps consider other methods of cooling the valve than merely the seat and bushing contacts. Again, a matter of design.

Since the urge for higher compression ratio comes from the desire for more horsepower output per cubic inch and better economy, the writer feels that the supercharge method of approach should be given very much better attention than it has had so far. It is quite obvious that horsepower per cubic inch (of the engine displacement known) can be doubled by supercharging which means that since the supercharger is always less costly per cubic inch of displacement, and per pound of weight, than the engine, it ought to be possible to build the whole engine assembly as cheaply as the present single stage compression. In order to get the economy it will be necessary to provide means for using the wasted exhaust energy from the engine. It looks like a natural to do this by way of a turbine driving the blower. This would imply considerably higher supercharge than has hitherto been utilized (except in racing engines), so as to utilize the total energy of the exhaust for this purpose. If this is done, then the turbine and supercharger need not be geared to the engine.

If the automotive industry is shown that it is necessary, it surely can cut the octane demand of the present single stage compression engine by at least 12 octane numbers, which would take nearly all of the step required to allow us to reach 12.5:1 c.r. It would also be logical to consider supercharging and two-stage expansion by way of the exhaust turbine to get economy. It is just as true of the internal combustion engine as it was 40 years ago on the steam engine-steam turbine situation, that the turbine is the better device for low pressure gases at large specific volume; and in all probability positive displacement (that is the reciprocating engine or some similar device, perhaps even a rotary) should retain the high pressure end. The major reason why it should is that if we are to retain the high temperature of combustion which we have now in the reciprocating engine and which is responsible for efficiency, we must have something at the hot end that can be cooled.

The conclusion then is that since we shall not be likely to get compression ratios much higher than 12.5:1 for a long period of time and since the engine designer can take up most of the slack on octane while the oil industry is doing what it can to raise the octane value, it will be absolutely necessary that the automotive industry take over this task. While it has been customary in the past for the oil industry to do pretty much what the automotive industry demanded, we have now reached very close to our predictable limit. It will be recognized, and it is being recognized, that the oil industry should not be asked to spend 5 to 10 times as much to accomplish the results as it would cost the automotive industry to do it even better, and with much more effective conservation and utilization of our natural resources.

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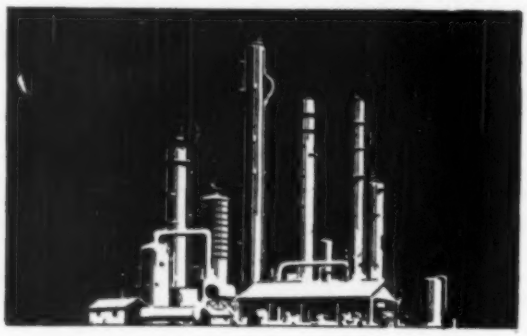


Foreign Patent Library, U. S. Patent Office, Washington, D. C.

Inventions and Patents

Part II

ARTHUR H. SEIDEL and Z. D. BONNER
Gulf Oil Corporation, Washington, D. C.

UNDER the Patent Office Rules of Practice the inventor may prepare and prosecute his patent application before the Patent Office himself, and in the rare instances involving inventors with much experience in these matters, this practice is successful. However, it is almost always advisable to have competent patent counsel handle the preparation and prosecution of a patent application. The obtaining of patent protection for a modern invention involves the most complex procedure in our whole body of law, and includes many pitfalls and traps for the unwary.

Thus perhaps the most important step from the inventor's point of view in obtaining a patent is the selection of a suitable patent attorney or agent to assist him in the filing of his patent application. The Patent Office maintains a roster of registered patent attorneys and agents, and only those listed will be permitted to represent applicants before the patent examining divisions. The Patent Office draws a distinction between "patent attorney" and "patent agent" based on whether or not the individual has been admitted to the bar of one of the states or the District of Columbia. If not so admitted the practitioner is merely entitled to represent himself as a "patent agent." There is, however, the important exception involving persons admitted to practice before the Patent Office prior to 1938. Such persons, regardless of whether or not they are members of the bar, are entitled to represent themselves as "patent attorneys." A word about advertising attorneys — ethical practitioners frown upon this, and members of the bar are strictly forbidden to do so. At the present time the Patent Bar Association is attempting to have the Patent Office adopt a rule which would prevent members of the roster from advertising.

AS WAS NOTED in the first section of this two-part series, the patent system has played an important role in the industrial development of our country. Misconceptions exist among technical people and executives in nearly every industry, however, regarding the nature of the patent grant and the manner in which inventions should be protected. A better understanding will pay rich dividends. In this section, the authors discuss the procedures to be followed in securing patents, and the functioning of the Patent Office.

Having selected competent patent counsel, the first step by the counsel prior to writing the patent application is to have a novelty search made in the United States Patent Office. While all research should be prefaced with a preliminary survey of the prior art, the normal library tools such as Chemical Abstracts, Beilstein, etc. are not adequate for a complete coverage of the prior art. The only truly adequate searching facilities from the patent point of view are the archives of the Patent Office, made available to the public by the Patent Office Search Room. There the approximately 2½ million issued United States patents are arranged not only numerically, but also as to subject matter. The whole sphere of patentable technology is broken down into over 300 major classes of patent groups, and about 45,000 subclasses within the major classes.

It is only by conducting, or having an associate conduct, a search within this immense classified network of issued patents that a patent advisor can arrive at an opinion relative to the patentability of any disclosure. If the disclosure is found to be patentable, the prior art search will be of great value to the patent attorney when the patent application is drafted as it will enable him to ascertain the extent of novelty of the disclosure, and there-

fore permit him to place it within its correct setting as determined by the prior art.

The patentability search is only one of many varieties which the patent attorney can render. Other types of searches include the infringement search, in which the claims of all pertinent patents issued within the previous 17 years are read to determine whether or not a given development infringes any active patents. The validity search is really a greatly extended patentability search. This search is made to determine whether a patent is valid, and is usually made by a prospective purchaser or licensee under a patent, or by the defendant in a patent infringement suit. All conceivably pertinent United States and foreign patents which issued prior to the one under consideration are examined, and in addition an exhaustive search is usually made through the literature. The object is to determine if there is any earlier written description which would negate the validity of the patent.

Searches of this type lasting six months or more are not uncommon, and in one instance known to the authors a validity search extended over a period of two years. The state-of-the-art search is simply what the name implies. All patents having a bearing on a proposed development are collected. Thus a manufacturer entering a new field, such as a petroleum company desiring to manufacture detergents, should have such a search conducted to see the extent of the prior work in this field.

Date: October, 1949 Page 288.2

Class 260, CHEMISTRY, CARBON COMPOUNDS

SYNTHETIC RESINS
FROM PHENOLS OR PHENOXIDES
ALDEHYDES
CONDENSATION PRODUCTS OF PHENOLS OR PHENATES
POLYHYDRIC PHENOLS
PHENOL OR C-METHYL PHENOL
FURFURYL COMPOUND
FORMALDEHYDE
WITH POLYHYDRIC ALCOHOLS OR THEIR ETHERS
WITH SUBSEQUENT TREATMENT
NEUTRALIZATION
WITH ORGANIC POLYHALIDES
WITH UNSATURATED HYDROCARBONS
FROM KETONES
WITH ALDEHYDES
WITH AMINES OR AMIDES
WITH POLYMERIZED UNSATURATED COMPOUNDS
FROM ALDEHYDES
WITH NITRO-, N-, CYCLIC COMPOUNDS
AZINES (E. G., MELAMINE)
(NUCLEAR) -N-NITROGENOUS RADICAL
(NUCLEAR) -S-, RADICAL
WITH UREAS
FORMALDEHYDE
WITH ADDITIONAL ORGANIC REACTANT
WITH SUBSEQUENT TREATMENT
WITH AMINES OR AMIDES
AROMATIC AMINES
WITH VINYL COMPOUNDS
POLYHYDRIC ALCOHOL-POLYCARBOXYLIC ACID REACTION PRODUCTS
WITH MONOCARBOXYLIC ACID OR ANHYDRIDE THEREOF
WITH MONOHYDRIC ALCOHOL
CARBOXYLIC ORGANOMETALLIC OR METALLOID ACID REACTION PRODUCTS
ALKYNE-CARBOXYLIC ACID REACTION PRODUCTS OR ANHYD.-FORM. POLYCARBOXYLIC ACID ($C_nH_{2n-2}O_4$)
CYCLOCARBOXYLIC ACID REACTION PRODUCTS
POLYCARBOXYLIC ACID REACTION PRODUCTS
INTERPOLYMERS
SILICON-CONTAINING
ALKYLENE HALIDE-POLYSULFIDE CONDENSATION PRODUCTS
SULFUR, HYDROGEN SULFIDE, OR REACTIVE SULFUR COMPOUND REACTION PRODUCTS (S_x)
FROM POLYMERIZED UNSATURATED COMPOUND
FROM HALOGENATED ORGANIC COMPOUND
POLYMERIZED UNSATURATED COMPOUNDS
INTERPOLYMERS
THIOL OR MINE COMPONENTS
CONJUGATED DIOLEFINE (I.E., HAVING 2 OLEFINIC LINKAGES IN 1,3-POSITION) CONTAINING
NATURAL RUBBER
CRACKED PETROLEUM DISTILLATE

SYNTHETIC RESINS
POLYMERIZED UNSATURATED COMPOUNDS
INTERPOLYMERS
FROM CONJUGATED DIOLEFINE OR CYCLO-DIOLEFINE
WITH NITRILES
WITH HEAVY METAL CONTAINING POLYMERIZATION AID
WITH O-CONTAINING POLYMERIZATION AID
WITH N-CONTAINING POLYMERIZATION AID
WITH SUBSEQUENT TREATMENT
WITH CARBOXYLIC ACID ESTERS
WITH AROMATIC HYDROCARBON
WITH HEAVY METAL CONTAINING POLYMERIZATION AID
WITH O-CONTAINING POLYMERIZATION AID
WITH N-CONTAINING POLYMERIZATION AID
WITH SUBSEQUENT TREATMENT
WITH ACYCLIC HYDROCARBON
FROM NITRILES
FROM CARBOXYLIC ACID ESTERS
UNSATURATED ACID ESTERS
WITH HALOGENATED HYDROCARBON
WITH HYDROCARBONS
WITH HALOGENATED HYDROCARBON
WITH HYDROCARBON
FROM HALOGENATED HYDROCARBON
VINYLIDENE HALIDES
FROM HYDROCARBONS
FROM HETEROCYCLIC COMPOUND
FURANES
FROM NITRILES
FROM CARBOXYLIC ACID ESTERS
UNSATURATED ACID ESTERS
ACRYLIC, ALPHA-ALKACRYLIC OR HALO-ACRYLIC ACID ESTERS
FROM AMINES OR AMIDES
FROM KETONES
POLYMERIZED ALCOHOLS
FROM HALOGENATED HYDROCARBONS
ACYCLIC
FLUORINE CONTAINING
HALO-HYDROCARBONS
VINYL HALIDES
FROM HYDROCARBONS
TERPENES
AROMATIC
ACYCLIC
TRIPLE BOND
DIOLEFINES
WITH HEAVY METAL CONTAINING POLYMERIZATION AID
WITH O-CONTAINING POLYMERIZATION AID
WITH N-CONTAINING POLYMERIZATION AID

Page from Patent Office Classification Manual which Shows the Classification of Patents by Subject Matter.

Having completed the patentability search, and assuming that an affirmative conclusion has been reached, the next step is to have the patent counsel draft an application. In this the closest type of cooperation between the attorney and inventor is essential. The attorney should be advised of all variables that are critical, and also which conditions may be varied over a broad range. For example, if excellent results may be obtained with a given process such as a new Fischer-Tropsch type synthesis over a broad range of temperatures, but only between the pressures of 2 and 5 atmospheres and a thruput of 1 to 10, the failure to point out all of these factors may render the patent worthless. It is just as essential to reveal the non-critical variables broadly as it is to place the right limits on a critical factor, since the disclosure in a patent that 600 to 700° F. is the temperature range means that a would-be infringer can avoid the patent if, in fact, a temperature of 800° F. is suitable. On the other hand, the revelation of the variables which are inoperative, simply to broaden the disclosure, is equally inadvisable. The inclusion of misinformation within a patent only provides the defendant in an infringement suit with an excellent opportunity to attack the validity of the patent. As we have seen, a patent may be invalid for lack of novelty and also for failure to reveal the true nature of an invention.

It is always advisable to place the optimum range within a broad range in the application; if in a catalyst composition 3 to 10 percent cobalt is useful, but 6 to 8 percent is to be preferred, it is advisable to indicate this. The inclusion of such information prevents the later acquisition of "improvement" patents by others, based on the ground that the restriction to the narrow range furnishes superior results.

The inventor should always disclose all of the equivalents which may be employed in his application. If sodium is equally as good as potassium he should reveal this to the attorney. On the other hand, if recognized equivalents are not useful he should be careful to point this out. Thus, in the case of an invention dealing with soaps, sodium would not have the equivalent properties of potassium.

Working examples should, if at all possible, be provided. The working

examples should be selected judiciously; for instance, in an application dealing with a cracking process, the examples should show a variety of charge stocks, catalysts, process conditions and results. Concerning results, if examples showing prior art data as compared with data utilizing the inventor's procedure can be furnished, they will be of material assistance to the attorney.

If a procedure is of wide utility this should, of course, be revealed. A disclosure concerning a new method for catalyst regeneration should reveal that it is applicable to a wide variety of processes. For example, if it could be used with cracking, reforming, alkylation, polymerization, etc. methods, this feature should be enlarged upon. A point of singular importance often overlooked by inventors is the statement of alternative modes of operation in process type cases.

When the attorney has submitted a draft application to the inventor for approval or comments the inventor should carefully examine it. This cannot be overstressed. As stated before, under our patent laws all applications are filed over the signature of the inventor, and not over that of the attorney, or the inventor's employer. While the inventor may confer to others by power of attorney, the right to amend his application once it has been filed, his approval is required for the initial filing. Furthermore, it is not permissible to add new matter to the application after it has been filed. Accordingly, he should check all statements in the specification for their factual veracity and completeness of coverage.

At the close of the specification will be found one or more "claims," which set out and define the limits of his invention. While these claims constitute among the most difficult of our legal instruments to draw, and should not be tampered with by the layman, they should be checked by the inventor to determine whether or not their coverage is sufficiently all-inclusive, and that they stress the salient points of the invention.

If the application includes drawings, these should likewise be checked. Patent drawings need not be drawn to scale but they must be drawn to a workable mechanism, and all aspects of the invention should be revealed. If the invention is for a chemical composition, it is not necessary to furnish a drawing. Patent applications for processes should include either a diagrammatic or a schematic type flowsheet. In flowsheets of the latter type, e.g. where reactors, distilling towers, etc. are represented by boxes and circles the Patent Office requires that all the component parts be labelled. If the utility of the subject matter can be accentuated by graphical or other abstract visual means, it is usually advisable to accompany the application with a patent drawing illustrating this. On the other hand, nothing is so pointless as asking the attorney to submit a set of inconclusive graphs or data. This merely beclouds the issues and hinders the eventual procurement of a patent.

Storage Room for "Soft Copies" of Patents, U. S. Patent Office, Washington, D. C.

Under the present practice it is not necessary to accompany the patent application with models or samples (except in the case of a perpetual motion machine in which event the Patent Office will demand to see a working model). Occasionally, during the later stages of the patent prosecution, it may be helpful to furnish the examiner with a demonstration or model. This, however is the exception, and not the rule, and barring exceedingly complex machine applications, which cannot be readily understood from drawings, or novel compositions of matter having totally unexpected properties, such a demonstration is pointless. The examining corps of the Patent Office, by and large, are a well trained body of men, thoroughly familiar with the technical fields in which they operate. Demonstrating a readily apparent feature to them accomplishes nothing, but may serve to irritate the examiner handling the case. His time is limited, and he may feel that the applicant is attempting to harass or high pressure him by the demonstration.

After the inventor has executed the necessary formal papers, his role is not yet finished as far as the Patent Office is concerned. Within a few months to somewhat over a year following his filing, the exact time depending on the type of invention, his attorney will receive an "Office Action" from the Patent Office. This is a terse, impersonal letter and usually states that all or part of the claims have been rejected as unpatentable for a variety of reasons. Usually prior art in the nature of literature references, or previously issued patents is cited to bolster the rejection. On rare occasions the first communication from the Patent Office will be a formal "Notice of Allowance," but modern patent practice limits this to the exceptional case.

The applicant must reply to the Office Action within six months (or a shorter time if the examiner for some reason requires a shortened time for reply), or the application becomes abandoned. His reply usually takes the form of an amendment, in which the applicant's attorney amends the claims to meet the examiner's objections. Alternatively the attorney may simply argue that the claims as they stand are patentable and not amend them. The reason the attorney does not desire to amend or cancel claims, without argument or the substitution of other claims is that once having done so he is forever prevented from claiming in the same application that the cancelled matter comprises the invention. The tactical sparring upon the part of the attorney has the ultimate goal of securing claims of sufficient breadth (called generic type claims) to cover all aspects of the applicant's invention, and specific (subgeneric) claims within the scope of the main generic claims to cover the optimum forms and modifications of the invention. The examiner's duty, on the other hand, is to limit the applicant's claims to those which are clearly outside the pale of the prior art.

The inventor can render the attorney a great assistance by examining the references cited by the patent examiner and indicating the distinguishing differences. It should be remembered that these differences must actually dis-

tinguish over the reference to be of any value in refuting the rejection. Thus if the examiner cites a reference which utilizes, in a petroleum process, a low-boiling naphtha charge, whereas the invention is limited to gasoils, the inventor must be able to prove that his invention performs differently with the latter type charge. The citation of irrelevant differences only serves to cloud the issue, so that unless there are meritorious grounds to a distinction, it is best not to present it in the reply to the Patent Office. In some instances, the attorney may decide that experimental confirmation of an argument is necessary, and in such cases he will request that an affidavit accompanied by experimental data be submitted with his amendment. He may ask the inventor to follow the procedure shown in the reference cited by the examiner, and the inventor may be able to show that different results from those of the invention are obtained.

Another instance in which affidavits are frequently used is the so-called "Affidavit Under Rule 131." Most frequently this affidavit is used when the examiner cites as a reference an American patent which issued within one year prior to the filing date of the inventor's application. Provided that this patent *discloses but does not claim* the present applicant's invention, the inventor may submit an affidavit to show that he completed his invention prior to the filing date of the patent. The affidavit should be accompanied by proof of this prior completion, such as photostats of pages from his laboratory notebook. Upon the acceptance of the affidavit, the examiner will withdraw the reference.

Eventually the examiner will allow all of the claims in an application, or some of them, or he may "finally reject" all of them. If the latter occurs the applicant is faced with the alternative of abandoning the "finally rejected" claims, or appealing from the examiner's decision. If he chooses the latter course, an appeal may then be prosecuted before the Patent Office Board of Appeals. This body will either affirm or reverse the examiner, and if the examiner is affirmed the applicant must appeal outside of the Patent Office if he wishes to pursue his application further.

"Interference"

A situation encountered in the Patent Office with about 4 percent of the applications is the condition known as "interference." This arises when two or more inventors attempt to obtain a patent for the same invention. The procedure that is followed to determine who was the first inventor, or the one entitled to a patent under our law, is among the most intricate in our whole judicial and administrative practice, and cannot be dealt with fully here. However, it involves ascertaining the dates of conception and reduction to practice, of each of the parties; and in the case of the ineventor who was the first to conceive but not the first to reduce to practice, whether or not due diligence was followed. It is in this type of proceeding more than any other, that accurate well-kept laboratory records "pay off." A large percentage of interferences are won and lost simply because one side failed to keep complete and authoritative records.

Many interferences are amicably settled between parties. This has the advantage of saving time, and curtailing legal expenses. However, in such a settlement, it is always necessary to determine who is the actual first inventor, and to agree to let him receive the patent. Otherwise as we have seen, the patent may later be declared invalid for not having been issued to the true inventor.

A word about fees. The official filing fee to be paid when the application is filed is $30 plus an additional $1 for each claim over 20. After the application has been allowed there is an additional fee of $30 plus an additional $1 for each allowed claim over 20. In addition to the foregoing there are additional fees for the filing of certain petitions, and also in the case of an appeal to the Patent Office Board of Appeals. While no conclusive statement may be made as to attorney's fees for any given application, the usual minimum cost for obtaining a patent if the inventor is represented by private counsel is of the order of $300. This minimum figure may be greatly increased if a complex invention is involved, or if appeals or interference are encountered in the prosecution before the Patent Office.

After the patent has issued, the Patent Office ceases to have jurisdiction over it, with one exception. This arises if the inventor discovers errors in his patent which arose due to his "inadvertence, accident, or mistake." In such an event he may file for a "reissue patent," by surrendering his earlier patent and reprosecute a corrected application before the Patent Office. If he is succesful in obtaining a reissue patent, it will terminate at precisely the same time his original patent would have expired. The rules governing reissues are highly technical, but it should be pointed out that the inventor will not be permitted to secure in his reissue anything which was not in fact part of his original invention.

If the claims of an issued patent are broader than the actual scope of the patentee's invention this may be corrected by the filing of a disclaimer with the Patent Office. Thus a patentee may disclaim "claims 1, 4 and 7" of his patent; or he may disclaim "so much of claims 1, 2, and 3 insofar as they relate to X."

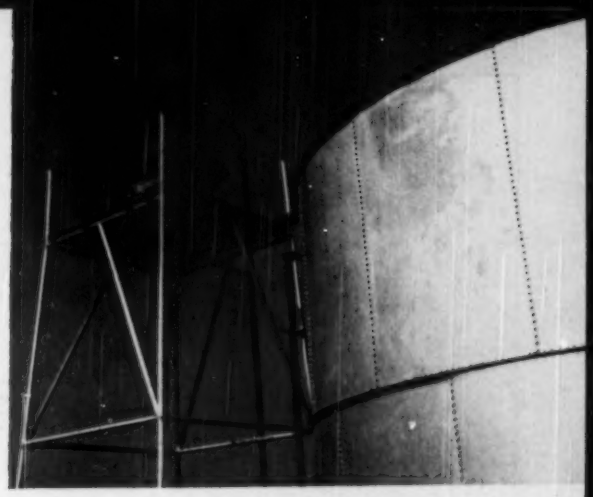
As has previously been mentioned, a patent merely gives its holder the right to prevent others from making, using or selling the protected invention within the United States for the life of the patent. The fruition of this right comes through the institution of an infringement suit in the federal courts against the infringer. The patentee may obtain an injunction preventing future infringement, as well as damages and an accounting for any past profits which the infringer may have made. In certain cases of deliberate infringement the patentee may obtain treble damages. However, as mentioned previously, one of the defenses available to the infringer is that the patent is invalid, and if he can get the court to agree with him the patentee will lose his patent.

Various uses may be made of patents. A patent can be assigned outright by the inventor to another person or to a company. An example of this is the case of an inventor employed by a corporation; as a consideration for his employment, the inventor usually signs a contract in which he assigns to his employer at the time of his employment any future inventions which he may make during the period of his employment. Besides assignment, the patentee may license others to either manufacture, use or sell under his patent. He may give an exclusive license to one party, or non-exclusive licenses to numerous individuals. He may charge a flat royalty, or a sliding royalty with the royalty per unit tapering off with the volume of units made or sold. He may give a territorial grant, such as rights within a particular geographical area or he may, if he wishes, simply donate his patent royalty-free to the public. In short, he is permitted a wide latitude of arrangements under his patent. The best mode of operation in any particular case will depend upon the type of invention, the condition of the industry, the position of the inventor, etc.

It is obviously impossible to cover the entire field of patent law in an article of this length. The writers have attempted, however, to point out some of the basic principles of patent law and to give inventors and executives in the industry a working knowledge of the patent system.

Process Gives Plant Water Free of Scale and Corrosion

JOHN C. ALBRIGHT
Santa Monica, Calif.



Coke-Filled Aerator for First Contact of Water With Treating, Where Iron and Manganese Are Oxidized So They Will Precipitate and Be Separated in the Receiving Tank at Right.

A WATER treating system installed by Barnsdall Oil Company at its absorption and compression plant near Newhall, Calif., provides ample water free of scale and corrosion. The process, detailed here, has proven so efficient that no cleaning, turbining or replacement of tubes has been necessary in the 20 months of plant operation and inspections show that the various inclosed exchangers, coolers, etc., and the interior of the processing equipment is remarkably clean.

BARNSDALL Oil Company's Rancho San Francisco Absorption and Compressor plant, near Newhall, Calif., obtains the major portion of operating water from 200-foot wells drilled in the Santa Clara River valley. The water is produced by gas-engine driven deep well pumps and boosted with auxiliary units to the first step for treating. This step consists of a coke aerator, with a receiving tank, both located on the crest of the range of hills between the gasoline plant and the river valley.

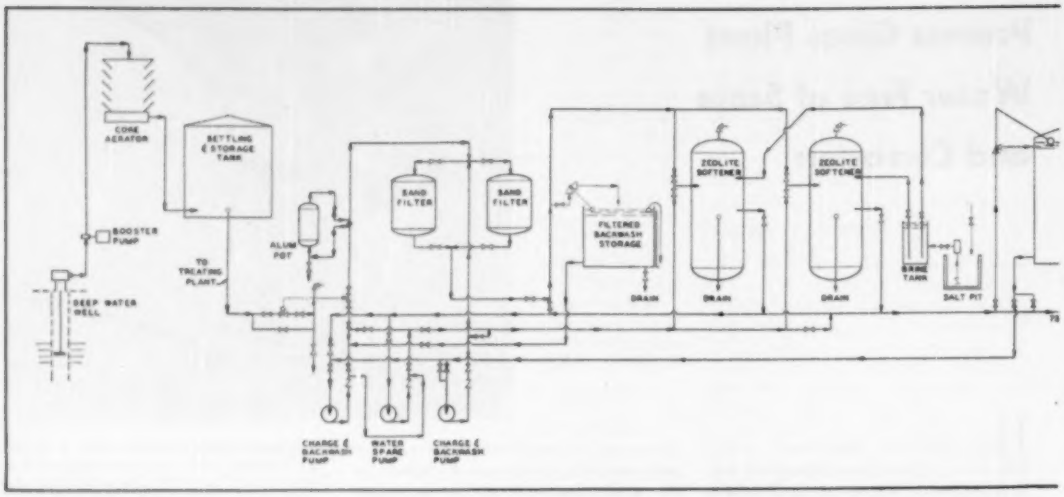
Water produced from these wells contains 40 grains hardness, plus traces of iron and manganese. Aerating the raw, freshly produced water by contact with coke in a circular structure equipped with two louvers, installed where maximum wind velocities are encountered, has proven an excellent method of oxidizing the iron and manganese so that most of it precipitates to the floor of the receiving tank. Constant blow-down, or bleeding, from the bottom of the tank prevents an accumulation of sludge and the iron and manganese oxide.

Since the water must be pumped across this high ridge between the lease and the river valley, the aerator and receiving tank were installed on the crest so as to obtain an automatic delivery head to the gasoline plant and engines of the pressure maintenance system.

The water flows, as consumed, from the tank on the ridge through a four-inch pipe line to the approximate center of the gasoline plant properties. The processing and storage section of the plant is surrounded by a six-inch pipe-line loop, to which all fire hydrants are attached. The four-inch delivery line is connected to this loop so that water under a head of about 135 psig. is always available for use in fog nozzles and conventional fire hose. The loop is fitted with block valves so that half of it may be cut out of service so that repairs or additional connections may be made without interrupting water flow to the plant. A branch line leads from this loop to two stand-by storage tanks where two high-pressure gas-engine-driven pumps are installed for emergency use in case of fire.

In normal operation the water flows into the loop, where it is free to travel in either direction to the second step in water treating. Water taken from the loop for treating and normal plant

Barnsdall's Rancho San Francisco Compressor Station Used in Conjunction with the Gasoline Plant and Control of Reservoir Pressures. Engines operate with radiator type jacket water coolers which are all attached to a common header to supply cooling water to all jackets irrespective of whether the engines are running.

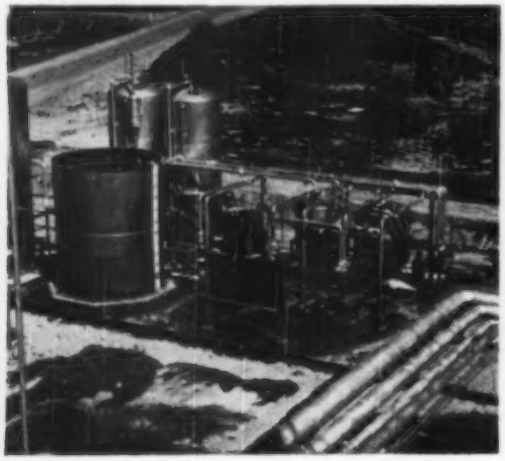


Pictured above and on the page opposite is a simplified flow diagram of the water treating system in Barnsdall Oil Company's R.S.F. absorption plant located at Newhall, Calif.

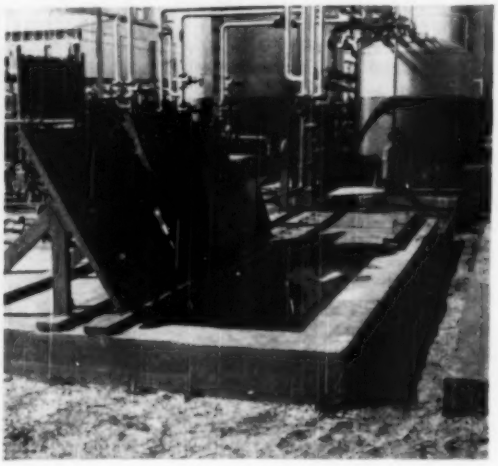
consumption is taken from a connection in the loop on the east side of the plant where the water conditioning equipment is located. The first contact by water in the treating process is through a split stream attached to an alum case which acts as a medium to coagulate the foreign matter, such as iron and manganese oxide. The floc obtained by coagulation is removed from the water by two sand filters, manifolded so that either or both may be used in processing, or one cut out of service for backwashing and reconditioning. Filtered water is used as makeup for the brine tank and other purposes around the plant where soft water is not required. Other than these uses, the main stream of water from the sand filters passes immediately to the zeolite softeners, each having a capacity of 100 gallons per minute. Like the sand filters, the softeners are manifolded so that either may be on stream while the other is being regenerated.

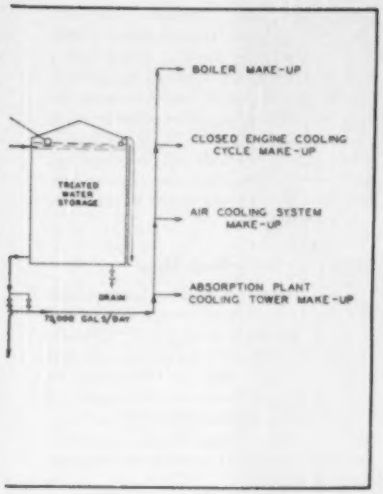
Salt water for regeneration of the softeners is obtained in a novel and different manner. The salt storage is a large concrete tank, set with most of its form below the surface of the ground, and having a capacity of a railroad carload of rock salt. The salt tank is located as near the east fence of the plant as practical to be accessible from the main lease roadway. Hinged lids permit opening one-half of the tank, or only a portion if a small vent is required. A concrete backstop is placed near the wall of the salt tank so that heavy three axle dump trucks can back up and dump 16 or 18 tons of salt quickly and without loss of time. By using an underground salt storage reservoir, handling of the salt by plant employes is not necessary. This saves the expense of a separate salt building as well as unloading sack by sack. The time required for filling the saline solution tank each time a softener is regenerated represents another saving. The water level in the salt tank is kept so high that most of the rock salt is submerged at all times, thereby supplying an adequate quantity of saturated brine for

Barnsdall's Softening Plant in the Gasoline Plant Showing Sand Filters At Right, With Alum Coagulator on Concrete Pad, Regeneration Pumps and Two Zeolite Vessels in Left Rear.



Barnsdall's Salt Storage, One Carload Capacity, May Be Filled from Dump Trucks so that Outside Storage is not Necessary. Supplies Regeneration Solution With Maximum Concentration of Salt.



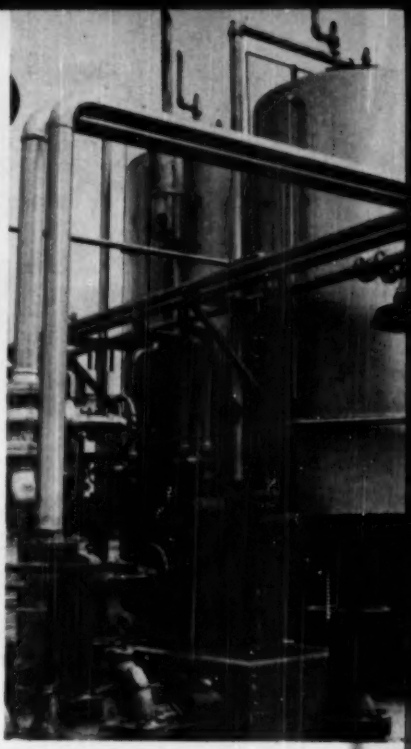


regeneration without waiting for salt to dissolve. A gravel-screened well is built into one side of the salt tank from which a small motor-driven centrifugal pump takes suction to maintain a working level in the brine tank at the softeners. Makeup for the brine concentration tank in which the supply of salt is stored is done by two methods: 1) The filtered water may be piped directly into the tank, or 2) the brine delivery pump can take suction on the softened water tank and return makeup by that method.

The sodium-zeolite water softeners may be operated in parallel or one at a time. They are on an operating basis of 32,000 gallons per regeneration which provides a rough rule of thumb for the operators to begin a close observation of the hardness of the water entering the soft water storage. Consumption of soft water by the gasoline plant and the compressor station is roughly 75,000 gallons per day, which makes it necessary to regenerate a softener approximately each 12 hours of the day. A close check is maintained on the condition of the soft water so that it never leaves the softeners having a hardness in excess of one-half grain. Tests for hardness of the treated water are made regularly instead of relying upon the quantity that the softener will produce without going off specification. Thus the tanks supplying the plant contain water approximating zero hardness.

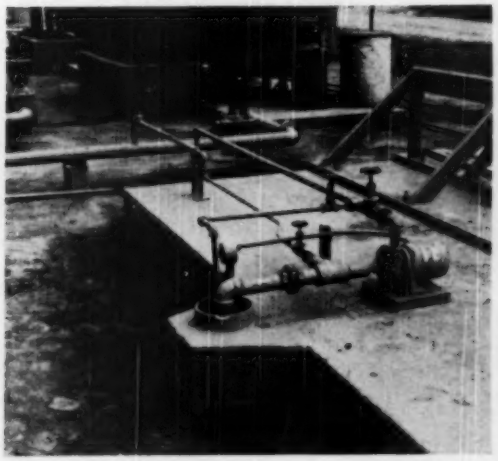
Softened water is withdrawn from the storage tanks for a variety of applications, the principal amount being makeup for the cooling tower basin. Makeup for gas engine jacket water coolers take their supply from the soft water tanks, and the supply of water required for the waste heat steam generators is obtained directly from the soft water storage. Approximately 25,000,000 btu. per hour is the absorption plant cooling load, of which approximately two-thirds is handled by water cooling. The remainder is handled with an aerial cooler that processes still overhead vapors to take the "sting" from the product before condensing in water-cooled shell and tube units.

The cooling tower is an enclosed structure, made of redwood for durability, 36 x 36 x 28 feet, divided into two separate portions, or cells to handle water at a rate of 2000 gallons per minute. The division of the cooling tower is complete from basin to roof, and each cell has its individual induced-draft fan and driving gas engine on the top deck. Both divisions can be combined, as is done during normal operations so that the water from both sections will flow into a common pit from which the circulating pumps take suction. The divided, or two-cell, construction was decided upon so that, when the cooling tower basin should

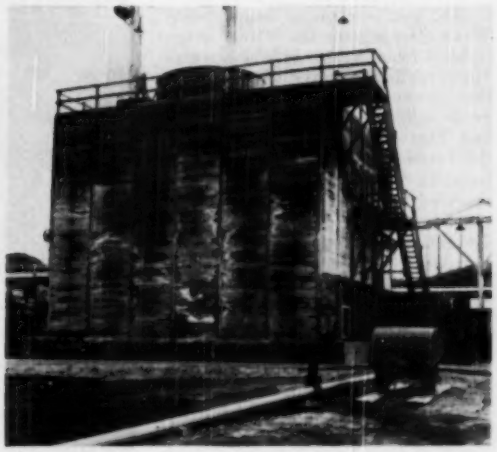


Zeolite Softeners Which Are Used to Maintain Makeup Water at Zero Hardness Before Being Used in Jackets or in the Cooling Tower Basin.

Brine Pick-Up Pump Which Keeps Regeneration Solution Tank Filled by Level Controls.



Water Cooling Tower is Closed with Light-Proof Siding to Prevent Growth of Algae. Fans Top of Tower Run with Gas Engines.



Acid Metering Reservoir Used to Introduce Sulfuric Acid So the Water Will Be Maintained With a pH of 7.5 to 8.0. Acid flows through plastic tube onto distribution trough so that no concentrated chemical will come in contact with either wood or metal.

require flushing, and the breakers and sidewalls become fouled, men might work inside without being exposed to a torrent of water, or a plant shutdown.

Water is guided through concrete flumes from each cell to the common suction pit where an unusual number of insect screens are installed. Four panels are placed in each of the two sections of the suction pit in guides so that either may be removed for cleaning. Three screens in each section are covered with common quarter-inch hardware cloth which stops the passage of the bulk of contaminants, such as bugs and grasshoppers. The fourth screen is fine mesh, similar to the metallic cloth placed on door and window screens and is made of copper wire. When cleaning, the last coarse screen is taken from the tier and the accumulated fouling removed. The first is then cleaned and placed in the third guide, with the center screen removed last. That which may pass through the third screen during cleaning is retained upon the fine mesh panel which is then removed and cleaned. This procedure eliminates virtually all of the accumulation before it is picked up by the circulating pumps.

Introduction of Acid

Water is treated in the cooling tower basin, after softening, with sulfuric acid injection from a metering pot on the side of the tower opposite from the circulating pumps. Acid is fed from the metering pot through a feeder adjusted to permit the required amount to enter the cooling tower water. A plastic tube conducts the acid from the blowcase into a diffusing trough so that contact between wood or metal and the acid is eliminated. The quantity of acid introduced into the cooling tower basin is set to maintain a pH between 7.50 and 8.00. Additional treatment is accomplished on the pump side of the cooling tower to prevent scale and corrosion.

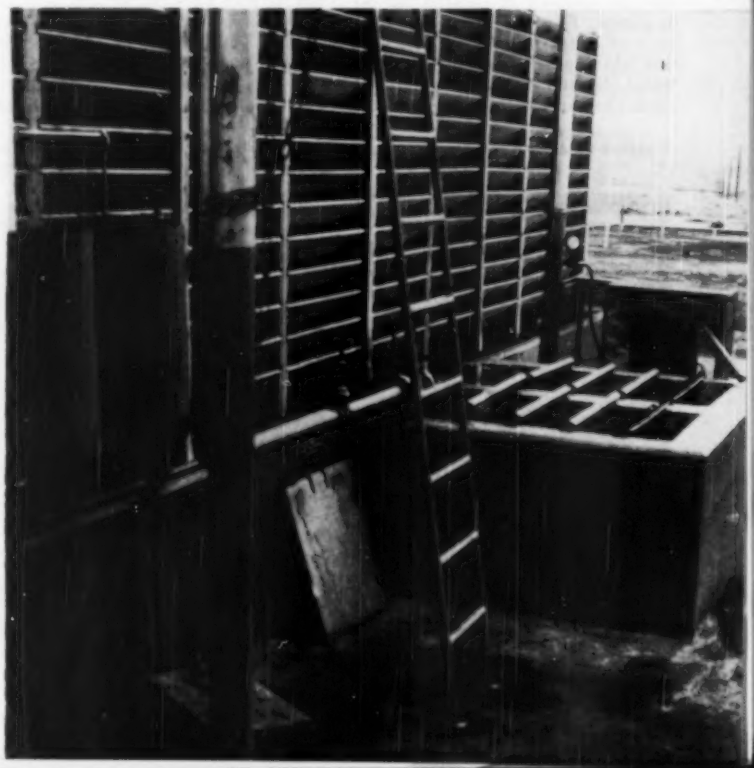
Two chemical pots are installed on the side of the cooling tower. The solution in these pots was originally fed into the water through a needle valve, but interruptions occurred when undissolved solids entered the orifice and shut off the flow. To overcome this difficulty, the pots are filled with the solution and allowed to spill through a small weir on the side above a certain level. Water, to force the flow of the solution, is fed into the pots through a needle valve which controls the flow of fresh, clean treated water. The outlet of the valve is fitted with a copper tube which leads to the bottom of the pot where it branches with the tips pointing in opposite directions so as to create the greatest possible turbulence in the bottom of the chemical pots. In this manner, the chemical is fed into the cooling tower basin without interruption.

Retarding Algae

Louvers on the cooling tower admit air for reduction of temperatures and exclude as much sunlight as possible. This was done in the anticipation that algae growth would be retarded. To supplement darkness in the control of algae, bromine is fed through an automatic injection apparatus in quantities which prevent any growth or propagation of algae.

Melroy Welch, superintendent of Barnsdall gas and gasoline operations, reports that periodic inspections have been made of the various enclosed exchangers, coolers, etc., and that the interior of all processing equipment is remarkably clean, and no cleaning, turbining, or replacement of tubes has been necessary in the 20 months of plant operation.

Trash and Insect Separators Consisting of a Series of Three Screens With Hardware Cloth With About ¼-inch Mesh, Followed by Last Screen, Covered With Copper Screen Wire About 1/16-Inch Mesh. Steel Panels at left against basin sides are irrigation type used to shut off either cell of tower when cleaning is necessary.

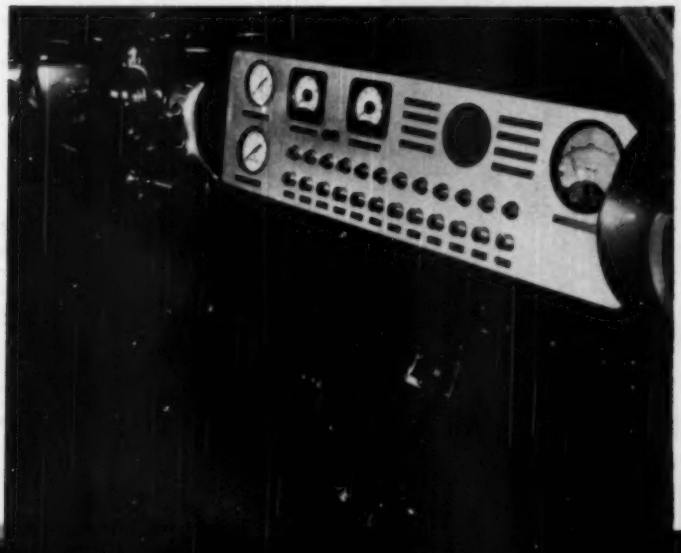


The trunk compartment of each car in the Du Pont fleet holds ten auxiliary fuel tanks, six for reference fuels and four for test fuels. The reference fuels are made to 92.5, 90, 87.5, 85, 82.5 and 80 octane number and are blends of iso-octane and n-heptane. Fuel lines from each tank are attached to solenoid valves with quick release fittings. The valves are actuated by pushbuttons on the instrument panel. A fusible plug set-up is designed to ring an alarm bell in case of fire. Carbon dioxide is released into the trunk compartment through a button at the driver's position.

Road Testing Evaluates Gasoline Performance

Du Pont Sends Fleet of Cars on the Road

Test car instrument panels designed to blend with the original dashboard. Pushbuttons for venting, for tank fuel, and for reference and test fuels are in line on the lower part of the panel. Above them are red lights which indicate the fuel being used. To the left of the buttons is the exhaust pressure indicator. From left to right in the upper portion are intake vacuum, engine speed, spark advance indicators, and a temperature selector dial and temperature indicator. On the car's floor is a window through which flywheel calibrations are read and the operating handle which controls spark advance settings.



THREE DuPont Company gasoline-test cars are on a 15,000-mile tour of the nation to illustrate what road testing of gasoline means, how tests are made and to provide information on performance of fuel stocks under road conditions.

The cars, which outwardly look like standard 1950 models, are designed to determine octane ratings of motor fuels under road conditions and to demonstrate methods of rating gasoline. The dashboard has been replaced by an elaborate instrument panel, and in addition to the conventional gasoline tank, ten smaller tanks have been installed in the luggage compartment for holding various types of fuel.

A battery of pushbuttons on the instrument panel permits the driver to draw gasoline from any of the tanks. Also on the panel, an aircraft-type gauge makes it possible for the operator to determine temperatures of engine, radiator water, oil, and outside air.

Other instruments show manifold vacuum, engine speed, back pressure of the exhaust, and spark advance.

Unlike conventional cars, the test autos are equipped with a hydraulic device which allows the driver to advance or retard the spark. Spark changes, coupled with engine speed readings, provide information which helps determine octane values. The degree of spark change is visible to driver or observer through a window in the floorboard and an opening in the flywheel housing.

The tour will take the cars into all the nation's major gasoline refining and marketing areas.

High-pressure Hydrogenation Of Carbonaceous Matter

PART VII

THE VAPOR PHASE

(Section B)

PETER W. SHERWOOD
Koppers Company, Inc., Pittsburgh

***HIGH-PRESSURE** hydrogenation is expected to play an important part in any American synthetic oil program. It offers also a useful approach to increased gasoline yields from low-grade petroleum crudes and fractions.*

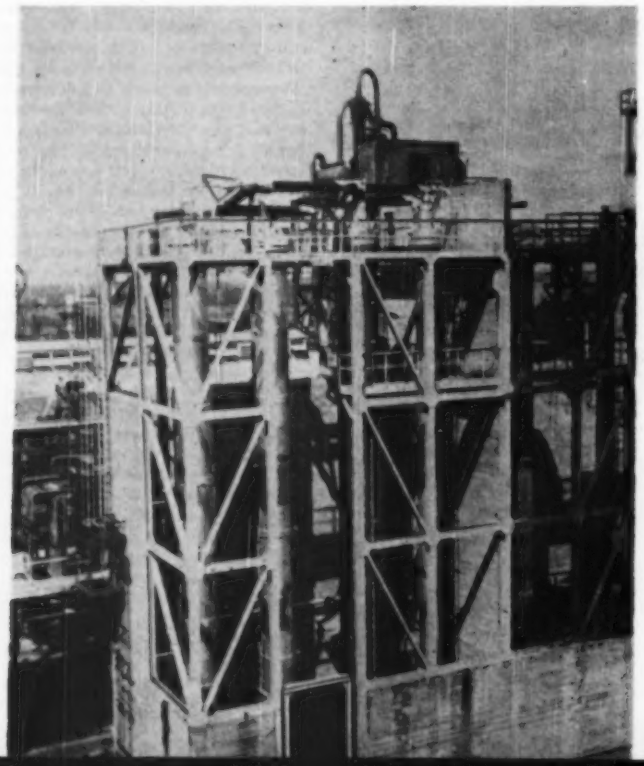
This seventh article in a series of eight considers a number of schemes by which vapor-phase hydrogenation and cracking may be combined to best advantage for the production of gasoline. Consideration is also given to the use of vapor-phase hydrogenation for the manufacture of high-grade lube oils and diesel fuels from low-grade stocks.

Performance of the Combined 4400-psi. Vapor-Phase Stages

We have seen that the vapor-phase at 4400 psi. must generally be carried out in two stages—presaturation and splitting. The splitting stage, which is the core of the process, fulfills the principal function of reducing the high-molecular weight compounds of charging stock (boiling point up to 610° F.) to hydrocarbons in the gasoline range, together with some hydrocarbon gas formation, yielding a highly aromatic and knock-resistant fuel as product. Catalysts employed in this stage are quite sensitive to nitrogen bases and oxygenated compounds as well as to asphaltic compounds in the feed. Where such components exist in the charging stock, it is necessary to introduce a presaturation stage in which a strongly hydrogenating catalyst refines the feed stock at the same time that it carries out a preliminary splitting action.

The operation of the presaturation stage is characterized by considerable variation in throughput, temperature, hydrogen consumption, etc. as may be required by the feed stock. Highly aromatic middle oils require a much more drastic hydrogenation treatment than is required for more naphthenic or paraffinic raw materials (it must be understood, of course, that suitable petroleum fractions, low in oxygen and nitrogen content, may need no presaturation treatment at all).

Front View of Vapor-Phase Stell



Less flexibility is practiced in the splitting stage which is generally called upon to convert a charging stock of reasonably uniform degree of hydrogenation and essentially free of organic bases and oxygen compounds. While the presaturation process is carried out as a once-through operation, splitting employs a recycle amounting to 30-50 percent on the fresh feed. Conditions in this stage for the manufacture of aviation base gasoline differ from conditions for the production of motor fuel in the use of more drastic time-temperature conditions, a higher recycle ratio, and the selection of a narrower (more volatile) gasoline fraction for removal from the system. The recycle oil has an adequate hydrogen content for amenability to the splitting action which is fully the equal of the fresh feed. In this, the hydrogenation process differs markedly from cracking operations in which the recycle stocks are generally quite refractory to further processing.

The accompanying Table 1, due to Gordon[1] summarizes the conditions encountered in the two-stage vapor-phase hydrogenation which is generally operated at 3650-4400 psi. The raw material for the reported operations is a middle oil derived from creosote oil.

The consumption of utilities and services for two-stage vapor phase operation does not differ greatly for various middle oil feed stocks. The following requirements are typical per barrel of motor gasoline.[2]

HP Steam	50 pounds
LP Steam	147 pounds
Fuel Gas	31 Btu
Electric Power	16.5 kwh
Cooling Water	2500 gallons

High-pressure hydrogenation may be carried out on selected cuts with a certain reduction in gas formation, since in this operating method the operating conditions may be more adequately adapted to the character of the feed. This so-called "Selective" Destructive Hydrogenation" process has been employed by Standard Oil Company (New Jersey) for the conversion of narrow-boiling fractions to aviation fuels, special naphthas, etc.[3] An Italian hydrogenation plant of ANIC distills and separates its crude into straight-run gasoline, kerosine, gasoil, and residuum. The gasoil is subjected to high-pressure hydrogenation in the vapor phase while the residuum is similarly hydrogenated in the liquid phase.[4] This latter process is already outside the scope of selective hydrogenation but is of particular interest because it illustrates the proper approach to the hydrogenative treatment of different petroleum fractions.

TABLE 1
Typical Full-Scale Operating Conditions and Yields for Vapor-Phase Hydrogenation of Creosote Middle Oil

Process	(a) Single Stage Gasoline Production	(b) Saturation Stage 2-stage Process	(c) Splitting Stage 2-stage Process	(d) Splitting Stage 2-stage Process
Catalyst	5058 (WS_2)	5058	6434 (Dilute WS_2)	231 (Iron Base)
Gasoline Mode	Premium Grade Motor Spirit 45 percent Vol. at 100° C.	Feed for (c) and (d)	Premium Grade Motor Spirit 45 percent Vol. at 100° C.	Base Spirit for 100 Octane Fuel 72 percent Vol. at 100° C.
Make-up feed rate, lbs./ft.³ catalyst/hour	36.7	75	53	34.3
Total oil feed rate to hydrogenation stall, lbs./ft.³ catalyst/hour	68.5	75	81	62.5
Vaporizing gas rate, ft.³/ton total oil fed	64,000	90,000	51,000	55,000
Cooling gas rate, ft³/ton total oil fed	55,000	61,000	20,000	27,000
Volume percent hydrogen in inlet gas	85	87	83	86.5
Volume percent hydrogen in exit gas	82.5	85	80	85.5
Total pressure inlet converter, psi.	3,850	3,850	3,850	3,850
Total pressure exit converter, psi.	3,750	3,750	3,750	3,750
Average reaction temperature °F. (with medium age catalyst)	790	725	782	807
Pass conversion of middle oil	54%	100%	66%	88%
Gasoline yield wt. percent middle oil converted:				
Butane free	86.5	.....	68.5	75.0
Butane	3.5	.....	3.5	0.5
Total	90.0	100	92.0	75.5
Total hydrocarbon gas yield, incl. C_4 in gasoline wt. percent of middle oil converted	10.8	1.5	13.0	27.5
H_2 chemically absorbed, wt. percent middle oil converted	8.4	8.1	3.0	3.5
Total hydrogen used, wt. percent middle oil converted	8.8	8.5	3.4	4.2

Vapor-Phase Hydrogenation At 10,300 psi.

Hydrogenation plants which operate a 10,300 psi. liquid phase may find certain operational advantages in carrying out the vapor phase at the same pressure.

Operation at such high pressures shifts the aromatics-naphthenes equilibrium further in favor of naphthenic compounds which can be split more readily than aromatic compounds. As a result, it is possible to raise the operating temperature to a higher level than is feasible at 4400 psi. without hazarding the formation of polymeric substances which lower the effective yield and endanger the activity of the catalyst. By judicious selection of catalyst and operating conditions, it becomes possible to produce a gasoline at 10,300 psi. which is more highly aromatic and knock-resistant than any that can be safely manufactured in the presence of the accepted splitting catalysts operated at 4400 psi.

A corrolary of the thermodynamic effect of hydrogen at highest pressures is the possibility of eliminating the hydrogen-addition features of the presaturation stage entirely. A single-stage vapor-phase hydrogenation over the normal 10 percent WS_2 on Fuller's earth catalyst (6434) at 10,300 psi. has been carried out at one German plant (Lützkendorf), starting with a middle oil charging stock which was unusually low in nitrogen and oxygen compounds (the feed stock to the liquid phase was largely petroleum residuum). Reaction temperature at this plant was 860° F. and feed rate was only 50 pounds per cubic foot per hour—about the same as for the combined stages of the 4400-psi. process. Only a small conversion per pass is possible—roughly 40 percent—to avoid the breakdown of the gasoline product into gaseous components. Proper operating conditions will produce gasoline in almost the same yield which can be obtained in two-stage operation at 4400 psi.

The small permissible conversion per pass is a disadvantage which plagues 10,300-psi. vapor-phase operation in all forms. It defeats all savings which might have been hoped for in the distillation required for this operating mode. (Two-stage operation usually—but not always—calls for two distillation systems. Single-stage vapor-phase operation is adequately served with a single product distillation.)

At the present stage of development, it cannot therefore be said that 10,300-psi. single-stage operation is incontestably superior to the two-stage operation at 4400 psi. The operational disadvantages encountered at Lützkendorf apply with equal force to the Ruhröl high-pressure catalyst which has, during recent years, aroused much interest and which is scheduled for operation in the U. S. Bureau of Mines plant at Louisiana, Mo.

From a product point of view, the Ruhröl catalyst is superior to 5058-6434 operation at 4400 psi. in that it yields a more highly aromatic gasoline, whose octane number is by 5-6 points higher. Thus, the Ruhröl catalyst is capable of producing in a single stage at 10,300 psi. a gasoline which is qualitatively fully equal to the product of two 4400-psi. stages (tungsten sulfide) plus one low-pressure hydroforming stage.

The Ruhröl catalyst, developed at the Bottrop - Welheim hydrogenation works, is composed of molybdenum, chromium, zinc, and sulfur on a Fuller's earth base. The catalyst is prepared by treating Fuller's earth with hydrofluoric acid and kneading the product with zinc oxide, sulfur, and chromic acid in the presence of water. The product is neutralized by means of ammonia and is then treated with an ammoniacal thiomolybdate solution. The product is extruded and dried. Final activation takes place in a stream of hydrogen at 500° F. maximum temperature.

This type of catalyst has the tremendous operational advantage over other high-pressure splitting catalysts of being quite impervious to the presence of nitrogen and oxygen compounds and of even being able to tolerate the presence of moderate amounts of high-boiling substances.

Because of its weakly cyclizing but strongly aromatizing and splitting characteristics, this catalyst achieves its best results with naphthenic (or aromatic) feed stocks. Paraffinic raw materials are less suitable.

Very high temperatures are employed. The following average conditions have been reported for industrial operation:[5]

Temperatures	935-935° F.
Inlet Gas	80,000-84,000 cu. ft./ton feed
Cooling Gas	8000-19,000 cu. ft./ton feed
Space-time yield	25 lbs. gasoline/ft.³ catalyst/hour
Conversion per pass	40-45 percent

The low-cooling gas requirements can be explained by the predominance

of splitting over hydrogenation reactions. The total hydrogen consumption in the 10,300-psi. vapor phase over Ruhröl catalyst is only about 5.5-7 percent on the feed stock.

It has been reported that a space-time yield as high as 37-43 pounds gasoline/ft³ catalyst/hour has been obtained in pilot-plant installations. These capacities have not so far been proven on an industrial scale. Their establishment will be an important task of the U. S. Bureau of Mines.

A striking feature of the Ruhröl catalyst is the much more weakly isomerizing action than is exhibited by tungsten sulfide catalysts. The butane gases, e.g. contain only about 25 percent isobutane (compared with 75 percent at 4400 psi.)

High-pressure conversion of suitable feed stocks over Ruhröl catalyst for the production of aviation gasoline (clear O.N. 78-80) can be accomplished in somewhat higher yields than at 4400 psi. over tungsten sulfide followed by hydroforming. The gasoline yield produced in the high-pressure units alone (i.e. excluding hydroforming) is somewhat higher in the case of 4400-psi. operation. An important factor in favor of the lower pressure is its greater versatility in regard to feed stock selection.

Hydrogenation and Cracking

The basic objectives of high-pressure hydrogenation and cracking are the same—the breakdown of high-molecular oils into hydrocarbons of lower molecular weight. From the point of view of performance, hydrogenation offers striking advantages in yield of primary product (usually gasoline) and the essentially complete elimination of coke and tar formation. The gasoline manufactured by high-pressure hydrogenation processes is highly stable (practically completely devoid of olefinic compounds) and free of sulfur, oxygen, and nitrogen compounds. The main disadvantages of the high-pressure process are the high capital cost of equipment and the costs of hydrogen production.

Murphree and co-workers[6] have reported an interesting comparison between the cracking and hydrogenation performances with the same crude. The cracking operation was carried out thermally and was followed by reforming and distillation. The hydrogenation, carried out in the vapor phase, was followed by distillation and some naphtha reforming for volatility. No reduced crude was employed in the process. Crude bottoms amounting to 9.4 percent on the crude were used as fuel. See Table 2.

TABLE 2

Cracking vs. Hydrogenation of West Texas Crude

Type Operation	Case A Thermal Cracking	Case B Hydrogenation
Overall Yield on Crude:		
Gasoline, vol. percent	41.3	54.5
Heating Oil, vol. percent	28.7	37.8
Heavy Fuel Oil, vol. percent	26.4	9.4
Gas, weight percent	3.5	1.8
Runs per 10,000 bbl. day of gasoline plus 6940 bbl. day of heating oil:		
Crude consumed, bbl./day	24,200	18,350
Fuel Oil Produced, bbl./day	6,400	
Total feed to hydrogenation		10,850
Inspections:		
Gasoline:		
Reid vapor pressure, psi.	10.0	10.0
Distillation, percent over at:		
158° F.	20.7	21.2
212° F.	43.1	43.5
257° F.	67.9	66.6
ASTM Octane No.	69.6	66.0
C.F.R. Research (1939) Octane No. or TEL to 81.5 C.F.R. Research (1939) Octane No.	74.3	68.4
	1.5	1.5
Heating Oil, gravity, °API	32.2	35.8
Fuel Oil, gravity, °API	9.0	
Viscosity, Saybolt Furol seconds at 122° F.	130	

TABLE 3

Operating Cycle	Case A Cracking Only	Case B Cracking Plus Hydrogenation
Yield on Crude:		
Straight run, 400° F. end point	35.0	35.0
Gas oil cracking	28.9	21.3
Reduced crude cracking	2.1	2.1
Hydrogenation		10.5
Cracking hydro gasoil		4.6
Butane loss	—1.3	—0.6
Total Gasoline	64.7	72.9
Octane No. (C.F.R.)	59.9	60.0
Reid Vapor Pressure	10.0	10.0

The hydrogenation and cracking processes can be combined in a number of ways to good advantage. By proper design of the combined processes, it becomes possible to produce gasoline in nearly the same yields as in pure hydrogenation operation but to effect an appreciable saving in the required high-pressure reaction space.

One such scheme involves the hydrogenative presaturation of the feed stock (if so required—this step may be omitted in the case of cracking feed stocks exhibiting a high aniline point and containing little nitrogen and oxygen). The presaturated product is distilled for the separation of gasoline from the middle oil (gas oil up to 620° F.). The gas oil is then subjected to thermal or catalytic cracking. After separation of the gasoline from the cracking products, the residual cracking product is subjected to a high-pressure splitting stage. The combined gasoline obtained from the combined presaturation, cracking, and splitting stages has been reported to have a clear octane number of 75-76 which can be raised to 89-90 by the addition of .12 percent tel. (the feed stock in this work was the middle oil produced by liquid-phase hydrogenation of bituminous coal, i.e. a highly aromatic raw material.[7]

An alternative method eliminates the high-pressure splitting stage entirely. As described by Russell and co-workers,[8] this process involves the recycling of the gas oil separated from the cracking products to high-pressure presaturation for the purpose of upgrading the recycle stock. The presaturated product is returned to the cracking coils, and the cracked gas oil is again returned to presaturation, etc. This "cracking plus hydrogenation process" obtains much better yields than can be obtained from cracking only. The product gasoline exhibits, of course, all the normal characteristics of straight cracking products and must be stabilized either by mild hydrogenation or by acid treatment.

The salutary effect of the combined "cracking plus hydrogenation" process on the yield, as compared with straight cracking operation, has been reported by Russell[8] for an East Texas crude as shown in Table 3.

The favorable effect of hydrogenative treatment of cycle stocks from catalytic cracking on yields and product has been demonstrated by Brown and co-workers[9] who studied the combination of high-pressure hydrogenation with fixed-bed as well as fluidized

TABLE 4

Fixed-Bed Catalytic Cracking with Synthetic Catalyst of Feed Stocks Derived from East Texas-Van Zandt-Talco Mixtures

	Virgin Gasoil	Cracked Cycle Stock	Hydrogenated Cycle Stock	
Feed:				
Degree of Hydrogenation			Partial	Almost complete
Volume percent on virgin gasoil	100	64	66	70
Gravity, °API	26.9	27.2	31.0	33.0
Aniline Point, °F	188	156	165	181
Sulfur, weight percent	1.10	.78	.21	.06
Hydrogen, weight percent	12.9	12.2	13.0	13.7
Yields:				
Conversion, volume percent	49.8	43.2	58.5	67.7
Gasoline, volume percent	42.5	33.7	46.6	55.4
Gasoil, volume percent	50.2	56.8	41.5	32.3
Excess C_4 volume percent	8.8	6.9	10.5	13.6
C_4 and lighter, weight percent	4.5	4.1	5.7	6.4
Carbon, weight percent	3.8	5.2	4.5	2.9
Gasoline:				
Reid vapor pressure, psi.	10	10	10	10
Octane No. (ASTM Motor)	80.2	80.0	80.6	80.4
O. N. (Motor+3cc tel/gal.)	86.5	87.9—88.6	90.1	90.1

catalytic cracking. Table 4 taken from this work, shows that the performance with hydrogenated cycle stock is actually superior to cracking results obtained with virgin gas oil and, of course, even more advantageous to cracking obtained with the untreated refractory recycle stock. In evaluating this table properly, it must be kept in mind that the same feed rate and cycle length were employed in each case. The picture for hydrogenation-plus-cracking would show up even more favorably if the same level of conversion had been set up as criterion for the cracking conditions selected for the various charging stocks.

Specialty Products from Vapor-Phase Catalytic Conditions

Properly guided, high-pressure hydrogenation over fixed bed catalysts of the type employed for the vapor phase may be made the basis for the production of a number of specialty products.

The middle oil which serves as recycle to the splitting stage may, if so desired, be withdrawn for use as cracking stock or as diesel oil. Even more ideally suited for these uses is the middle oil obtained by presaturation. This material is a water-white hydrogenated gasoil, lower-boiling than the original feed, which because of its high hydrogen and low sulfur content exhibits excellent diesel oil properties.

High-boiling end products such as diesel oil and lubricants are produced at highly hydrogenative, weakly splitting conditions, i.e. at moderate temperatures in the presence of a strongly hydrogenating catalyst of the presaturation (pure WS_2) type. Under such conditions, the hydrogen content of the oil is raised while a strongly refining action is exercised at the same time. Breakdown of the carbon skeleton is secondary and the basic molecular structure of the raw material is only slightly affected.

Where a suitable raw material is available, the reaction can be carried out in the liquid phase over a fixed catalyst at substantially the same operating conditions encountered in vapor-phase hydrogenation. The requirements on the charging stock for this mode of operation are the absence of insoluble and asphaltic components and of unsaturated products which might tend to polymerize and deposit on the catalyst.

The process has been employed by Standard Oil Company (New Jersey) at Bayway, N. J., for the manufacture of lube oils.[10] The reaction is carried out in the liquid phase at 800° F. and 3000 psi. and yields a lubricating oil of very high viscosity index and a high degree of refinement.

A plant for the production of diesel and lubricant oils by high-pressure hydrogenation at moderate temperatures has been described by Howell and Crawford.[11] The raw material was lignite L.T.C. tar which had been effectively freed of inorganic solid matter by centrifugation and filtration.

The conversion was carried out in the presence of pure WS_2 (presaturation catalyst) between 680° and 730° F. at a total pressure of 4400 psi. The predominant reaction medium under these conditions is liquid tar. Throughput rates are low, averaging about 25 lbs/ft.^{3} catalyst/hour. Hydrogen consumption is roughly 4.5-5.5 weight percent on the feed stock.

The flow of both oil and gas in this operation is in upward direction. Abrasion of catalyst in the liquid phase is a less serious problem than in the pure vapor phase. Probably because of the unavoidable presence of asphaltic and insoluble matter, however, catalyst life in this particular plant (Zeitz) was only 4-6 months (compared with about two years for normal 4400 psi. vapor phase operation and approximately one year for operation with Ruhröl catalyst at 10,300 psi.) The use of a more suitable feed stock would probably result in better performance.

The yield of crude product under these operating conditions varies between 90-95 percent on the raw tar. A typical product distribution for this particular feed stock has been reported.[2]

TABLE 5

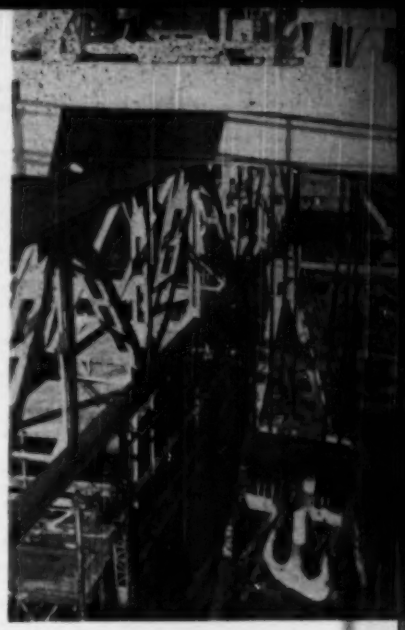
		Operating Temp. 680° F.	Operating Temp. 730° F.
Gasoline	Percent weight on Product	25	35
Diesel Oil		50	60
Refined Wax		10-15	
Lube Oil		10-15	
Heavy Bottoms			5
Hydrocarbon gas, percent weight on original tar		1-2	6
Hydrogen used, percent weight on original tar		4.4	5.6

TABLE 6

	Feed Stock	Refined Product
API gravity	22.0	29.2
Viscosity at 100° F.	3100	580
Viscosity at 210° F.	144	58.7
Viscosity index	72	101
Carbon	3.31	.13

TABLE 7

	Feed Stock	Refined Product
Specific Gravity at 20° C.	.990	.881
Phenols (percent)	22	.3
End Point (°C.)	354	337
Aniline Point (°C.)	8	56
Cetane number	0	60
Pour point (°C.)		−18



Crane for High-Pressure Equipment

The refining and improving action of hydrogenation on lowgrade diesel oils is illustrated by Pier[13] in Table 7.

The gasoline produced in the course of this process version has an octane number of only about 55 and requires after-treatment. The viscosity index of the composite lube oil fraction is between 60-80.

The treatment can be applied to best advantage to high-sulfur paraffinic petroleum feed stock to produce lube oils of high quality. Haslam and Russell[12] converted a very viscous Mid-Continent lube distillate by high-pressure hydrogenation with the effect shown in Table 6. The process yielded 25 percent gasoil and gasoline as unavoidable by-product.

Properties and After-Processing of Vapor Phase Gasolines

Gasolines produced by high-pressure hydrogenation in the vapor phase are highly refined and stable. Regardless of feed stock, the following properties are exhibited universally by such gasolines[8]:

a) They require no treating except a caustic wash to insure passing the corrosion and doctor tests.

b) They are high in color (+30), have virtually no gum, and are low in sulfur (less than .03 percent).

c) They have normal distillation characteristics in spite of the very aromatic quality of some of the feed stocks.

d) They are highly susceptible to

TABLE 9

Feed Stock Properties	API Gravity	Aniline Point	REMARKS
A) Light Cycle Gas Oil	21.5	52° F.	Very refractory cracked stock
B) California Cycle Gas Oil	22.4	77	Refractory cracked stock
C) Venezuela Gas Oil	25.1	106	Mixed virgin-and-cracked stock
D) East Texas Gas Oil	26.6	203	Approximately 15 percent, cut on E. Texas crude, over 15 percent bottoms

Hydrogasoline Properties	Aniline Point	API Gravity	Octane No. CFR
Gasoline from Feed Stock:			
A	160° F.	58.0	61
B	171	59.0	56
C	170	60.0	57
D	196	64.0	48

TABLE 8

	Motor Gasoline	
	Specific Gravity	Octane No. (Motor Method)
Middle Oil Feed from:		
Paraffin	.680	48
Crude oil, mixed base	.772	64
Crude oil, asphalt base	.728	67
Shale oil, paraffinic	.712	65
Shale oil, asphaltic	.732	66
Lignite L.T.C. tar	.734	65
Lignite liquefaction	.735	66
Crude oil cracking residue hydro.	.745	74
Bitum. coal liquefaction and extraction	.745	74
Bituminous coal high temp. tar	.748	75

tetraethyl lead, resembling in this respect the most lead-susceptible straight-run gasolines.

Hydrogenation gasolines are highly stable in storage. Their storage stability is generally still further enhanced by the addition of small amounts of cresols (or similar tar acids) which act as inhibitors.

The effect of operating conditions on the physical and engine performance characteristics of hydrogasolines has been presented in preceding parts of this series. Perhaps an even more significant effect is exerted on the properties of the product by the nature of the feedstock. This influence is, to be sure, considerably less in the vapor phase than has been found true of the liquid phase, but it is pronounced nevertheless. The comparison, Table 8, due to Pier,[14] illustrates the profound effect of the feed stock on the product of vapor phase hydrogenation under comparable operating conditions:

Similar results, Table 9, due to Russell and co-workers[8] and relating entirely to the high-pressure hydrogenation of various petroleum products, demonstrate the effect of feed stock properties on the characteristics of the hydrogasoline:

The properties of the gasoline obtained in the presence of the aromatizing Ruhröl catalyst at 10,300 psi. are similarly dependent on the nature of the feedstock. As has already been pointed out, this mode of hydrogenation operates to best advantage on a naphthenic or aromatic feed. A typical gasoline produced at Ruhröl conditions by the vapor phase conversion of bituminous coal liquefaction middle oil exhibits properties[15] shown in Table 10.

The gasoline product of two-stage vapor-phase hydrogenation at 4400 psi. has an octane rating which is definitely inferior to 10,300-psi. operation in the presence of strongly aromatizing catalysts and conditions, and is per se unsuitable as an aviation gasoline base. Upgrading can be carried out in a number of ways, among which a version of hydroforming has attained the greatest field of application.

Hydrogasoline is separated into two fractions. Only the cut boiling above 185° F. is subjected to the hydroforming operation which is carried out in the presence of hydrogen at a total pressure between 350 and 1000 psi. and at a temperature between 930°-985° F. The catalyst is 8-10 percent molybdic acid on alumina. Average throughput rates are 28-30 pounds feed/ft³ catalyst/hour. Gasoline yields vary between 72 and 80 weight percent on the feedstock. It should be noted that the naphthenic nature of hydrogasolines leads to less carbon deposition than is generally encountered in similar hydroforming operations with more paraffinic feedstocks. The on-stream portion of the operating cycle in this type of operation may therefore be as high as 240 hours.

The effect of this hydroforming operation on hydrogasoline has been reported, Table 11, for a feedstock derived from the liquefaction and subsequent vapor-phase hydrogenation of lignite and lignite tar.[16]

TABLE 10

	Aviation Gasoline
°A.P.I.	54
Boiling range, °F	105-320
Aromatics, percent	63
Naphthenes, percent	35
Paraffins, percent	20
Olefins, percent	2
Sulfur	Below .02
Octane No. (Motor Method)	80
Octane No. M.M.+3 cc. tel./gal.	94
Reid vapor pressure, psi.	7

TABLE 11

	Light Gasoline 32-185° F.	Naphtha Feed to Hydroforming 185-355° F.	Stabil'd. Hydrof'g. Product	Final Hydrof'g. Gasoline Blend
Aniline Point (°C.)	52	45	1.6	6.9
Aniline Point after sulfuric acid treatment (°C.)	55.4		63.2	61.0
Weight percent aromatics	4.5	9.5	66.0	52.0
Weight percent naphthenes	46.2	51.2	7.9	14.4
Weight percent paraffins	48.7	38.1	25.9	33.0
Weight percent olefins	0.6	1.2	0.6	0.6
Octane No. (M.M.)	73.5	52.0	82.5	80.5
Octane No. (M.M.) with .12 v. l. percent tel				91.5

* * *

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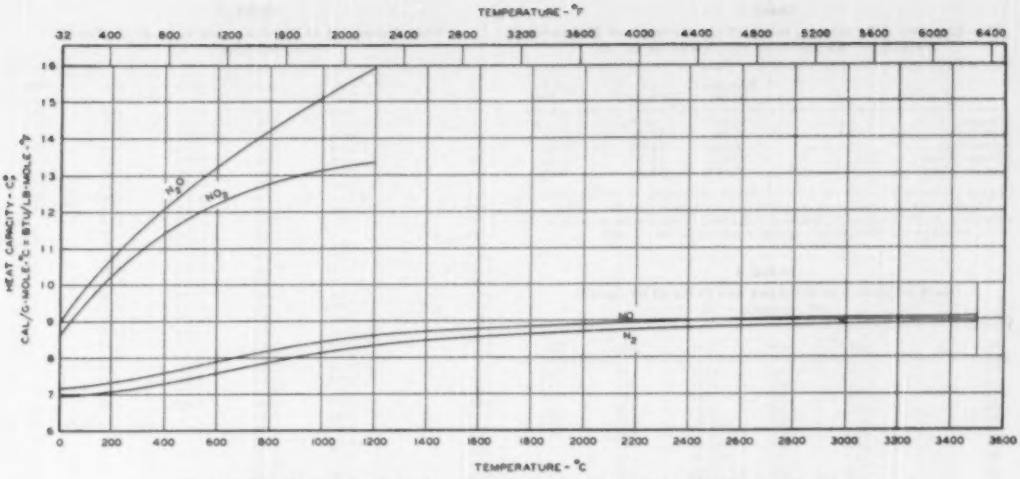

Figure 1. Heat Capacity Curves for Nitrogen, Nitrous Oxide, Nitric Oxide and Nitrogen Dioxide.

THE THERMOCHEMICAL properties of the following groups of compounds have been presented in previous papers of the series: paraffinic hydrocarbons,[28] monoolefinic hydrocarbons,[29] cycloparaffinic hydrocarbons,[30] acetylenic and diolefinic hydrocarbons,[31] combustion gases,[32] sulfur compounds,[33] halogens and halogen acids,[34] chloromethanes,[35] and the cyanogen compounds.[36] This paper presents the data for the oxides of nitrogen—nitrous oxide, nitric oxide, nitrogen dioxide and its dimer, nitrogen tetroxide, and repeats the data for nitrogen for comparative purposes. The oxides of nitrogen are of importance as a refrigerant (N_2O), as an oxidizing and nitrating agent (NO_2, N_2O_4) and for the fixation of nitrogen and formation of nitric acid (NO, NO_2).

Dr. Kobe is a professor of chemical engineering at the University of Texas and Mr. Pennington is the 1949-50 Celanese Corporation fellow in Chemical Engineering there.

THERMOCHEMISTRY for the Petrochemical Industry

Part XII—Oxides of Nitrogen

KENNETH A. KOBE and R. E. PENNINGTON
Department of Chemical Engineering
University of Texas, Austin

SOURCES of heat capacity data for nitrogen, nitric oxide, nitrous oxide, nitrogen dioxide, and nitrogen tetroxide are given in Table 1. The data for nitrogen were given in a previous paper[32] in this series. Goff and Gratch[11] have since presented slightly different data for nitrogen which were calculated using the International Steam Tables value of the gas constant, R, 1.98581 cal./gm.-mole · °K. If their data are corrected with the best scientific value of R, 1.98719 cal./gm.-mole · °K, the difference becomes well within the accuracy of the calculations.

The statistical calculation of the properties of nitric oxide from spectroscopic data is a very interesting problem (note in Table 3 the unusual behavior of the heat capacity at the lower temperatures). It was first successfully attacked by Johnston and Chapman,[16] whose results were later corrected slightly by Witmer.[48] These data have been brought up to date in the API 44 report,[41] and it is from that source that the data given here are derived.

TABLE 1
Reported Heat Capacity Data for Nitrogen and Some of Its Oxides

	Temperature Range	Method	Workers	Reference
Nitrogen	−181 and +20° C.	Calorimetric	Scheel and Heuse	43
	304 to 477° K.	Calorimetric	Eucken and Von Lude	8
	20 to 370° C.	Calorimetric	Henry	14
	481 and 691° K.	Calorimetric	Eucken and Mucke	9
	0 to 1000° C.	Velocity of sound	Dixon, Campbell, and Parker	6
	400 to 3000° K.	Velocity of sound	Shilling	44
	50 to 5000° K.	Spectroscopic	Johnston and Davis	17
	0 to 3000° K.	Spectroscopic	Justi	18
	300 to 5000° K.	Spectroscopic	Wagman, Kilpatrick, Taylor, Pitzer and Rossini	47
	600 to 5400° R.	Compilation	Heck	13
	− 73 to 2750° C.	Compilation	Ellenwood, Kulik, and Gay	7
	298 to 4000° K.	Compilation	A.P.I. 44 Report	41
	300 to 6400° R.	Compilation	Keenan and Kaye	23
	298 to 5000° K.	Compilation	National Bureau of Standards	42
	100 to 5000° R.	Spectroscopic	Goff and Gratch	11
Nitric Oxide	− 80 to +15° C.	Calorimetric	Heuse	15
	180 to 2700° K.	Equilibrium Data	Shilling	44
	7.5° C.	Velocity of sound	Partington and Shilling	38
	0 to 5000° K.	Spectroscopic	Johnston and Chapman	16
	180 to 500° K.	Spectroscopic	Witmer	48
	20 to 3000° C.	Spectroscopic	Justi	21
	0 to 3000° C.	Spectroscopic	Justi	19
	0 to 4000° K.	Compilation	A.P.I. 44 Report	41
	0 to 5000° K.	Compilation	National Bureau of Standards	42
Nitrous Oxide	272 to 290° K.	Calorimetric	Eucken and von Lude	8
	25.1° C.	Velocity of sound	Clark and Kata	5
	0 to 3000° C.	Spectroscopic	Justi	20
	250 to 1500° K.	Spectroscopic	Kassel	22
	100 to 500° K.	Spectroscopic	Wacker	46
	273 to 1800° K.	Spectroscopic	Pennington	39
Nitrogen Dioxide	27 to 300° C.	Calorimetric	Berthelot and Ogier	2
	300 to 1000° K.	Spectroscopic	Kelley	24
	300 to 1500° K.	Spectroscopic	Woolley	49
Nitrogen Tetroxide	27 to 300° C.	Calorimetric	Berthelot and Ogier	2
	34 to 160° C.	Calorimetric	McCollum	27
	298 to 1000° C.	Spectroscopic	Kelley	25

TABLE 2

Free Energies of Formation, Heats of Formation, and Molecular Weights of Nitrogen and Its Oxides, at 25° C.[1]

	Molecular Weight	ΔG°_f cal./g-mole	ΔH°_f cal./g-mole
Nitrogen	28.016	0.0	0.0
Nitric Oxide	30.008	20,719	21,600
Nitrous Oxide	44.016	24,760	19,490
Nitrogen Dioxide	46.008	12,390	8,091
Nitrogen Tetroxide	92.016	23,491	2,309

[1] ΔH°_f and ΔG°_f represent the changes in the heat content (enthalpy) and free energy respectively, for the formation of the gaseous oxides from gaseous nitrogen and oxygen, with all the reactants and products in their appropriate standard reference states.

TABLE 3

Heat Capacities of Nitrogen and Some of Its Oxides
cal./g-mole · °C.

°C.	N_2	NO	N_2O	NO_2	N_2O_4
0	6.959	7.148	8.953	8.66	18.1
18	6.960	7.138	9.163	8.81	18.7
25	6.960	7.137	9.241	8.87	18.9
100	6.978	7.142	9.589	9.46	20.8
200	7.044	7.247	10.798	10.22	23.0
300	7.159	7.418	11.482	10.85	24.6
400	7.307	7.607	12.087	11.45	....
500	7.469	7.787	12.632	11.90	....
600	7.630	7.949	13.142	12.25	....
700	7.780	8.090	13.636	12.53	....
800	7.912	8.213	14.110	12.76	....
900	8.032	8.318	14.578	12.94	....
1000	8.138	8.405	15.051	13.10	....
1100	8.230	8.480	15.510	13.23	....
1200	8.311	8.543	15.966	13.33	....
1300	8.379	8.597	....	....	....
1400	8.441	8.649	....	....	....
1500	8.497	8.689	....	....	....
1750	8.612	8.778	....	....	....
2000	8.698	8.845	....	....	....
2250	8.765	8.899	....	....	....
2500	8.820	8.945	....	....	....
2750	8.866	8.984	....	....	....
3000	8.905	9.020	....	....	....
3250	8.937	9.052	....	....	....
3500	8.964	9.082	....	....	....

TABLE 4

Heat Capacities of Nitrogen and Some of Its Oxides
cal./g-mole · °K.

°K.	N_2	NO	N_2O	NO_2	N_2O_4
273	6.959	7.148	8.953	8.66	18.1
291	6.960	7.138	9.163	8.81	18.7
298	6.960	7.137	9.241	8.87	18.9
300	6.961	7.134	9.253	8.89	18.9
400	6.991	7.162	10.217	9.67	21.4
500	7.070	7.289	10.991	10.41	23.4
600	7.197	7.468	11.651	11.05	25.0
700	7.351	7.657	12.239	11.58	....
800	7.512	7.833	12.770	12.00	....
900	7.671	7.990	13.276	12.33	....
1000	7.816	8.126	13.766	12.60	....
1100	7.947	8.243	14.235	12.81	....
1200	8.063	8.342	14.705	12.99	....
1300	8.165	8.426	15.177	13.14	....
1400	8.253	8.498	15.631	13.26	....
1500	8.330	8.560	16.090	13.36	....
1750	8.486	8.681	....	....	....
2000	8.602	8.771	....	....	....
2250	8.690	8.840	....	....	....
2500	8.759	8.895	....	....	....
2750	8.816	8.941	....	....	....
3000	8.862	8.981	....	....	....
3250	8.900	9.017	....	....	....
3500	8.934	9.049	....	....	....
3750	8.964	9.079	....	....	....
4000	8.989	9.107	....	....	....

TABLE 5

Heat Capacities of Nitrogen and Some of Its Oxides
Btu./lb.-mole · °F.

°F.	N_2	NO	N_2O	NO_2	N_2O_4
32	6.959	7.148	8.953	8.66	18.1
60	6.960	7.139	9.135	8.79	18.6
77	6.960	7.137	9.241	8.87	18.9
100	6.962	7.127	9.371	8.98	19.2
200	6.976	7.136	9.918	9.41	20.6
300	7.004	7.178	10.401	9.84	21.9
400	7.047	7.250	10.830	10.25	23.0
500	7.107	7.340	11.220	10.64	24.0
600	7.180	7.442	11.581	10.98	24.9
700	7.262	7.547	11.917	11.30	....
800	7.351	7.652	12.238	11.58	....
900	7.440	7.751	12.538	11.83	....
1000	7.530	7.847	12.826	12.04	....
1100	7.618	7.934	13.108	12.23	....
1200	7.705	8.015	13.385	12.39	....
1300	7.785	8.093	13.656	12.54	....
1400	7.861	8.162	13.924	12.68	....
1500	7.932	8.225	14.183	12.79	....
1600	8.000	8.282	14.442	12.89	....
1700	8.063	8.336	14.704	12.99	....
1800	8.120	8.384	14.967	13.08	....
1900	8.175	8.429	15.223	13.15	....
2000	8.224	8.468	15.480	13.22	....
2100	8.271	8.506	15.732	13.28	....
2200	8.313	8.540	15.987	13.33	....
2300	8.352	8.576	....	....	....
2400	8.389	8.609	....	....	....
2500	8.424	8.635	....	....	....
3000	8.570	8.745	....	....	....
3500	8.675	8.828	....	....	....
4000	8.753	8.890	....	....	....
4500	8.817	8.942	....	....	....
5000	8.869	8.986	....	....	....
5500	8.911	9.025	....	....	....
6000	8.945	9.060	....	....	....
6500	8.976	9.092	....	....	....

TABLE 6

Heat Capacities of Nitrogen and Some of Its Oxides
Btu./lb.-mole · °R.

°R.	N_2	NO	N_2O	NO_2	N_2O_4
492	6.959	7.148	8.953	8.66	18.1
500	6.959	7.143	9.008	8.70	18.3
520	6.960	7.139	9.135	8.79	18.6
537	6.960	7.137	9.241	8.87	18.9
600	6.967	7.129	9.600	9.15	19.8
700	6.985	7.150	10.120	9.59	21.2
800	7.020	7.209	10.580	10.01	22.4
900	7.070	7.289	10.991	10.41	23.4
1000	7.135	7.382	11.369	10.78	24.4
1100	7.210	7.485	11.719	11.11	....
1200	7.298	7.588	12.048	11.42	....
1300	7.384	7.693	12.361	11.68	....
1400	7.475	7.792	12.654	11.92	....
1500	7.564	7.885	12.940	12.12	....
1600	7.655	7.969	13.220	12.30	....
1700	7.735	8.049	13.496	12.45	....
1800	7.816	8.126	13.766	12.60	....
1900	7.890	8.190	14.029	12.73	....
2000	7.960	8.251	14.287	12.83	....
2100	8.027	8.306	14.547	12.93	....
2200	8.085	8.359	14.810	13.02	....
2300	8.143	8.405	15.071	13.11	....
2400	8.195	8.446	15.326	13.18	....
2500	8.244	8.485	15.582	13.24	....
2600	8.288	8.521	15.834	13.30	....
2700	8.330	8.560	16.090	13.36	....
2800	8.368	8.591	....	....	....
2900	8.403	8.621	....	....	....
3000	8.438	8.646	....	....	....
3500	8.581	8.754	....	....	....
4000	8.682	8.834	....	....	....
4500	8.759	8.895	....	....	....
5000	8.821	8.946	....	....	....
5500	8.872	8.989	....	....	....
6000	8.913	9.028	....	....	....
6500	8.946	9.063	....	....	....
7000	8.977	9.095	....	....	....

The only calorimetric work done on the heat capacity of nitrogen dioxide was that of Berthelot and Ogier,[2] in 1883. Their results indicate a negative temperature coefficient for the heat capacity, which is an obvious error. The explanation is that at lower temperatures nitrogen dioxide exists as its dimer, N_2O_4, which dissociates rapidly with increasing temperatures (see Figure 4). The larger values of heat capacity at the lower temperatures also include heat of the reaction $N_2O_4 \rightarrow 2NO_2$. Kelley,[24] calculated heat capacity data using early spectral assignments, but since there was a slight inconsistency in these data they were recalculated and corrected here using essentially the same frequencies. However, a personal communication from H. W. Woolley,[45] of the Bureau of Standards, indicates that newer and better spectroscopic data are available, though as yet unpublished. He was kind enough to include his results for heat capacity based on these newer data, and it is on the basis of these results that the data in this paper were calculated.

Kelley[24] presents data for nitrogen tetroxide obtained with the spectral assignments of Harris and King.[12] However, this was only a tentative assignment in which it was not possible to rule out completely the possibility of a different structural model for the molecule. Southerland,[45] carried out an analysis using this other model and was able to make a most reasonable assignment on this

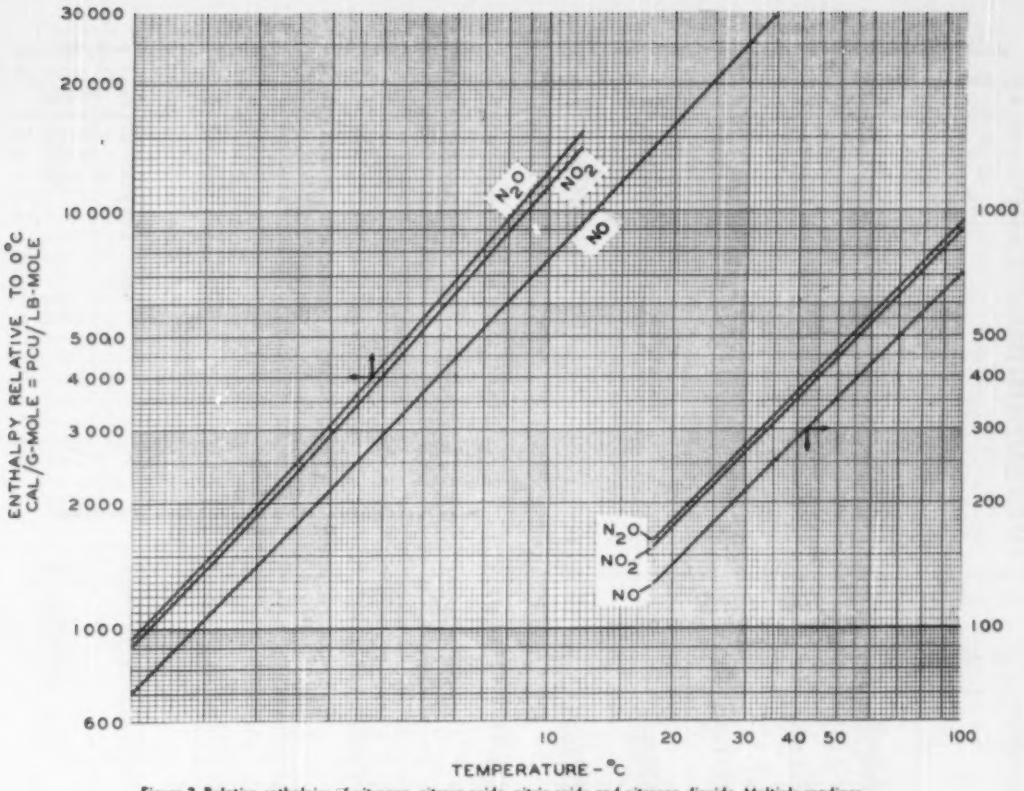

Figure 2. Relative enthalpies of nitrogen, nitrous oxide, nitric oxide and nitrogen dioxide. Multiply readings in Pcu/lb.-mole by 1.8 to obtain Btu./lb.-mole.

basis. The significant point is that the heat capacity values calculated from the two sets of data differ by as much as ten per cent at about room temperature. Of course this difference decreases considerably with increasing temperature, but nitrogen tetroxide is almost completely dissociated at 600° K., so the maximum deviation appears in the temperature range of interest. The data presented in this paper were calculated here with the Harris and King assignment, but it should be kept in mind that these results may be as much as ten per cent high.

The calorimetric results of Eucken and von Lude,[8] for nitrous oxide in most cases agree with the calculated spectroscopic data within their indicated experimental error. A very detailed analysis of the spectra of nitrous oxide has been made by Plyler and Barker[40] and later slightly corrected by Barker.[1] Their assignments have been

TABLE 7

Enthalpies of Nitrogen and Some of Its Oxides
cal./g-mole

°C.	N_2	NO	N_2O	NO_2	N_2O_4
0	0.0	0.0	0.0	0.0	0.0
18	125.3	128.5	163.0	157.3	331
25	174.0	178.4	227.4	219.2	463
100	696.5	712.3	949.6	903.5	1950
200	1397	1433	1990	1892	4140
300	2107	2165	3105	2945	6530
400	2830	2916	4284	4062	
500	3569	3684	5520	5230	
600	4324	4470	6809	6439	
700	5094	5272	8148	7678	
800	5880	6093	9536	8943	
900	6678	6913	10970	10230	
1000	7492	7749	12452	11530	
1100	8306	8595	13980	12850	
1200	9132	9451	15554	14180	
1300	9965	10308			
1400	10810	11170			
1500	11650	12038			
1750	13800	14222			
2000	15970	16425			
2250	18140	18644			
2500	20340	20875			
2750	22560	23117			
3000	24770	25368			
3250	27000	27628			
3500	29240	29894			

TABLE 8

Enthalpies of Nitrogen and Some of Its Oxides
cal./g-mole

°K.	N_2	NO	N_2O	NO_2	N_2O_4
273	0.0	0.0	0.0	0.0	0.0
291	125.3	128.5	163.0	157.3	331
298	174.0	178.4	227.4	219.2	463
300	187.9	191.5	2309	235.5	498
400	883.2	904.7	3294	1163	2520
500	1588	1628	4345	2168	4760
600	2301	2365	5478	3242	7200
700	3024	3120	6674	4375	
800	3766	3894	7924	5555	
900	4532	4684	9226	6772	
1000	5299	5490	10578	8019	
1400	8088	8308	11978	9290	
1200	6888	7137	13425	10580	
1300	7700	7976	14920	11886	
1400	8518	8823	16460	13207	
1500	9356	9677	18046	14538	
1750	11458	11832			
2000	13600	14014			
2250	15770	16218			
2500	17940	18434			
2750	20140	20663			
3000	22350	22906			
3250	24570	25158			
3500	26800	27412			
3750	29040	29678			
4000	31280	31950			

TABLE 9

Enthalpies of Nitrogen and Some of Its Oxides

Btu./lb.-mole

°F.	N_2	NO	N_2O	NO_2	N_2O_4
32	0.0	0.0	0.0	0.0	0.0
60	194.9	200.0	253.3	244.4	515
77	313.2	321.1	409.3	394.6	833
100	473.3	485.1	623.3	599 9	1270
200	1170	1196	1588	1519	3270
300	1868	1913	2605	2482	5400
400	2570	2635	3667	3487	7650
500	3277	3365	4770	4532	10000
600	3991	4103	5910	5613	12400
700	4713	4852	7085	6727	.....
800	5443	5611	8293	7871	.....
900	6182	6379	9532	9042	.....
1000	6929	7158	10800	10240	.....
1100	7686	7947	12097	11450	.....
1200	8452	8744	13422	12680	.....
1300	9227	9549	14774	13930	.....
1400	10009	10361	16153	13190	.....
1500	10799	11179	17558	16460	.....
1600	11600	12005	18990	17740	.....
1700	12400	12836	20447	19040	.....
1800	13210	13672	21930	20340	.....
1900	14020	14513	23440	21650	.....
2000	14840	15359	24975	22970	.....
2100	15670	16209	26536	24300	.....
2200	16490	17063	28122	25630	.....
2300	17340	17919	.....	.....	.....
2400	18180	18778	.....	.....	.....
2500	19020	19640	.....	.....	.....
3000	23280	23965	.....	.....	.....
3500	27600	28379	.....	.....	.....
4000	31950	32810	.....	.....	.....
4500	36340	37270	.....	.....	.....
5000	40780	41731	.....	.....	.....
5500	45210	46255	.....	.....	.....
6000	49670	50777	.....	.....	.....
6500	54150	55316	.....	.....	.....

TABLE 10

Enthalpies of Nitrogen and Some of Its Oxides

Btu./lb.-mole

°R.	N_2	NO	N_2O	NO_2	N_2O_4
492	0.0	0.0	0.0	0.0	0.0
500	55.7	59.4	74.7	72.2	151
520	194.9	200.0	253.3	244.4	515
537	313.2	321.1	409.3	394.6	833
900	751.9	772.8	1006	965.0	2050
700	1450	1486	1992	1902	4110
800	2150	2204	3028	2882	6290
900	2852	2930	4107	3902	8580
1000	3565	3663	5225	4962	11000
1100	4285	4407	6379	6056	.....
1200	5005	5160	7568	7182	.....
1300	5741	5924	8788	8337	.....
1400	6495	6697	10039	9517	.....
1500	7231	7480	11319	10720	.....
1600	8004	9273	12627	11940	.....
1700	8774	9073	13963	13180	.....
1800	9539	9882	15326	14430	.....
1900	10335	10698	16716	15700	.....
2000	11127	11521	18132	16980	.....
2100	11927	12349	19573	18260	.....
2200	12730	13183	21041	19560	.....
2300	13540	14021	22535	20870	.....
2400	14350	14864	24055	22180	.....
2500	15170	15712	25600	23500	.....
2600	16010	16562	27171	24830	.....
2700	16840	17417	28767	26170	.....
2800	17680	18276	.....	.....	.....
2900	18510	19136	.....	.....	.....
3000	19360	20000	.....	.....	.....
3500	23620	24352	.....	.....	.....
4000	27950	28749	.....	.....	.....
4500	32300	33184	.....	.....	.....
5000	36700	37644	.....	.....	.....
5500	41120	42130	.....	.....	.....
6000	45590	46635	.....	.....	.....
6500	50030	51160	.....	.....	.....
7000	54510	55699	.....	.....	.....

TABLE 11

Mean Heat Capacities of Nitrogen and Some of Its Oxides

cal./g-mole · °C.

°C.	N_2	NO	N_2O	NO_2	N_2O_4
0	6.959	7.148	8.953	8.66	18.1
18	6.960	7.139	9.056	8.74	18.4
25	6.960	7.136	9.096	8.77	18.5
100	6.965	7.123	9.496	9.05	19.5
200	6.985	7.165	9.950	9.46	20.7
300	7.023	7.217	10.350	9.62	21.8
400	7.075	7.290	10.710	10.16	.....
500	7.138	7.368	11.040	10.46	.....
600	7.207	7.450	11.348	10.73	.....
700	7.277	7.531	11.640	10.97	.....
800	7.350	7.616	11.920	11.18	.....
900	7.420	7.681	12.189	11.37	.....
1000	7.482	7.749	12.452	11.53	.....
1100	7.551	7.814	12.709	11.68	.....
1200	7.610	7.876	12.962	11.82	.....
1300	7.665	7.929	.....	.....	.....
1400	7.718	7.979	.....	.....	.....
1500	7.769	8.023	.....	.....	.....
1750	7.886	8.127	.....	.....	.....
2000	7.983	8.212	.....	.....	.....
2250	8.064	8.286	.....	.....	.....
2500	8.137	8.350	.....	.....	.....
2750	8.202	8.406	.....	.....	.....
3000	8.258	8.456	.....	.....	.....
3250	8.306	8.501	.....	.....	.....
3500	8.355	8.541	.....	.....	.....

TABLE 12

Mean Heat Capacities of Nitrogen and Some of Its Oxides

Btu./lb.-mole · °F.

°F.	N_2	NO	N_2O	NO_2	N_2O_4
32	6.959	7.148	8.953	8.66	18.1
60	6.960	7.143	9.046	8.73	18.4
77	6.960	7.136	9.096	8.77	18.5
100	6.961	7.134	9.166	8.82	18.7
200	6.984	7.118	9.452	9.04	19.5
300	6.970	7.137	9.720	9.26	20.1
400	6.984	7.161	9.965	9.48	20.8
500	7.002	7.190	10.192	9.68	21.4
600	7.026	7.224	10.405	9.88	21.8
700	7.053	7.263	10.606	10.07	.....
800	7.087	7.306	10.798	10.25	.....
900	7.122	7.349	10.982	10.42	.....
1000	7.158	7.395	11.157	10.58	.....
1100	7.197	7.441	11.327	10.72	.....
1200	7.236	7.486	11.491	10.86	.....
1300	7.277	7.531	11.651	10.99	.....
1400	7.317	7.574	11.808	11.10	.....
1500	7.356	7.615	11.960	11.21	.....
1600	7.395	7.656	12.111	11.31	.....
1700	7.433	7.695	12.258	11.41	.....
1800	7.471	7.733	12.404	11.50	.....
1900	7.507	7.769	12.548	11.59	.....
2000	7.542	7.804	12.691	11.67	.....
2100	7.575	7.838	12.832	11.75	.....
2200	7.607	7.870	12.971	11.82	.....
2300	7.645	7.900	.....	.....	.....
2400	7.675	7.930	.....	.....	.....
2500	7.707	7.958	.....	.....	.....
3000	7.843	8.081	.....	.....	.....
3500	7.959	8.183	.....	.....	.....
4000	8.051	8.269	.....	.....	.....
4500	8.133	8.342	.....	.....	.....
5000	8.204	8.404	.....	.....	.....
5500	8.267	8.459	.....	.....	.....
6000	8.322	8.508	.....	.....	.....
6500	8.371	8.552	.....	.....	.....

the basis of several calculations of the thermodynamic properties of this substance. Justi,[20] made extensive calculations but used only the fundamental frequencies and a harmonic oscillator approximation. Kassel,[22] included, to a very good approximation, the effects of anharmonicities and interaction of the vibrations, but used the slightly incorrect formula for the energy levels which was later corrected by Barker. Wacker[40] made extremely accurate calculations by mechanically summing the partition function for the molecule using the correct energy level equation, but his results cover a very limited temperature range. Pennington,[38] used the correct energy level formula and with approximations similar to those of Kassel calculated the data presented in this paper.

The latest available data for heats and free energies of formation and molecular weights are given in Table 2, being taken from the National Bureau of Standards compilation.[42]

Tables 3, 4, 5, and 6 present the molar heat capacities on all temperature scales. Figure 1 illustrates the temperature—heat capacity relationships of the individual compounds and the general relationships among the compounds in the group, except nitrogen tetroxide which exists over such a small temperature range.

The molal enthalpies relative to the icepoint (0° C. = 32° F.) are given in Tables 7, 8, 9, and 10 using all four temperature scales. The enthalpies were calculated from the heat capacity data using Lagrangian integration coefficients. The relative molal enthalpies are shown on a double logarithmic plot in Figure 2.

The mean molal heat capacities of these compounds have been calculated on the Centigrade and Fahrenheit scales, using the icepoint (0° C = 32° F.) as the base temperature. These values are given in Tables 11 and 12.

Empirical equations for the heat capacities have been derived over a stated temperature range and are given in Table 13 for all four temperature scales.

Nitrogen dioxide begins to dissociate to nitric oxide and oxygen at relatively low temperatures and is almost completely dissociated at 1000° C. The percentage dissociated at various temperatures at a pressure of one atmosphere is shown in Figure 3. These values were calculated from smoothed values of the logarithm of the equilibrium constant, as given by Giauque and Kemp[10] who corrected the original data of Bodenstein and Linder[4] for gas imperfection. The reaction $2NO + O_2 \rightarrow 2NO_2$ is one of the few known third-order gas reactions and is unique in that the rate decreases with increase in temperature. The dissociation reaction is of the second order.[50]

Nitrogen tetroxide dissociates readily and rapidly to form the monomer nitrogen dioxide, the dissociation being almost complete at 150° C. The percentage dissociated at various temperatures at a pressure of one atmosphere is shown in Figure 4. These values were again calculated from smoothed values of the logarithm of the equilibrium constant, as given by Giauque and Kemp from original data of Bodenstein and Boes[3] corrected for gas imperfection.

TABLE 13

Heat Capacity Equations for Nitrogen and Some of Its Oxides

Range: The equivalent of that indicated for the Centigrade scale

Equation: $C_p^\circ = a + b(t) + c(t^2) + d(t^3)$

Units: cal./g-mole · °C. or °K.

Btu./lb.-mole · °F. or °R.

Compound	T	a	b × 10²	c × 10⁶	d × 10⁹	Range	ERROR Max. %	ERROR Avge. %
Nitrogen (N_2)	°C.	6.919	1.365	— 0.2271	0.000	0-3500	2.05	0.72
	°K.	6.529	1.468	— 0.2271	0.000			
	°F.	6.895	0.7624	— 0.07000	0.000			
	°R.	6.529	0.8260	— 0.07000	0.000			
	°C.	6.931	0.5355	1.366	—0.6861	0-1200	0.59	0.34
	°K.	6.903	—0.3753	1.930	—0.6861			
	°F.	6.922	0.2646	0.4335	—0.1176			
	°R.	6.903	—0.2085	0.5058	—0.1176			
Nitric Oxide (NO)	°C.	7.090	1.947	— 0.0990	0.08729	0-3500	2.33	0.84
	°K.	6.461	2.356	— 0.7705	0.08729			
	°F.	7.015	1.101	— 0.2172	0.01497			
	°R.	6.461	1.310	— 0.2378	0.01497			
	°C.	7.100	0.8238	1.589	—1.000	0-1200	0.97	0.36
	°K.	7.008	—0.2344	2.328	—1.000			
	°F.	7.086	0.4262	0.4630	—0.1715			
	°R.	7.008	—0.1247	0.7185	—0.1715			
Nitrous Oxide (N_2O)	°C.	9.000	9.921	— 6.438	1.526	0-1200	0.80	0.26
	°K.	5.758	14.004	— 8.508	1.526			
	°F.	8.822	5.643	— 2.029	0.4331			
	°R.	5.758	7.780	— 2.626	0.4331			
Nitrogen Dioxide (NO_2)	°C.	8.62	9.48	— 6.88	1.88	0-1200	0.46	0.16
	°K.	5.48	13.85	— 8.41	1.88			
	°F.	8.45	5.40	— 2.15	0.322			
	°R.	5.48	7.58	— 2.60	0.322			
Nitrogen Tetroxide	°C.	18.1	29.8	—27.1	0.00	0-300	0.97	0.36
	°K.	7.9	44.6	—27.1	0.00			
	°F.	17.6	17.1	— 8.36	0.00			
	°R.	7.9	24.8	— 8.36	0.00			

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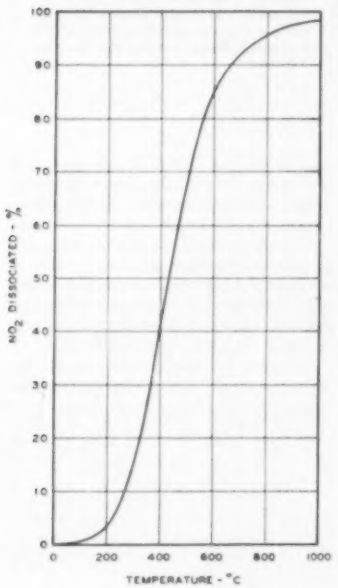

Figure 3. Dissociation of Nitrogen Dioxide.

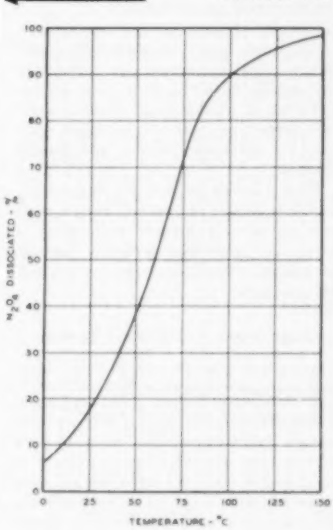

Figure 4. Dissociation of Nitrogen Tetroxide.

In the photo above, left, turbine components in the power generation section of the "More Power to America Special" are examined by J. W. Belanger, left, assistant general manager of the General Electric Company's apparatus department, and E. E. Parker, manager of engineering for the department's turbine divisions.

Buttons adjacent to components enable visitors to "light up" on the transparent bas relief in the background the sections of the turbine where components are located.

The G. E. train itself is shown in the photo above, right. Hauled by a 4500-hp., two-unit diesel-electric locomotive, itself one of the exhibits, it comprises ten modern stainless steel coaches built to specifications of the Chicago, Rock Island and Pacific Railroad, which line will buy them upon completion of the tour. Each exhibit car is equipped with its own undercar power plant which provides 30 kilowatts of power to operate exhibits as well as train lighting, heating and air conditioning.

GE Products and Ideas Form Cargo on Exhibit Train

MORE than 2000 products designed and built to produce, distribute and utilize electric power are displayed on the "More Power to America" special train which General Electric Company has started out from Schenectady, N. Y., on a tour that will take it to 150 industrial centers of America before 1951 ends.

At each stop, the train will be inspected by invited representatives of electric utilities, manufacturing and transportation industries, the armed services, the federal government, and municipalities. The train will not be open to the general public.

Representing a complete range of apparatus for industry, exhibits cover such equipment as turbines, substations, transmission equipment, motors of all sizes and ratings, complex drive systems, industrial lighting equipment, street lighting equipment, precision measuring instruments, welding and heating equipment, diesel-electric switchers, controls, and urban transit and railroad equipment.

Eleven Major Sections

Exhibits are grouped in 11 major sections: power generation, transmission and distribution; drives and controls; materials handling; welding; industrial heating; renewal parts; industrial lighting; components for industry; measurements; civic improvement, and national security.

Dramatizations of the latest welding cost reduction techniques, samples of various welds, a complete line of arc welding equipment and accessories and resistance welding control items are displayed in the welding section. New industrial arc welders, improved electrodes and new manual and automatic holders for the atomic-hydrogen inert-arc welding processes are included.

Samples of weld beads from hard-to-weld metals such as aluminum, magnesium, steel and copper are included in the welding displays, along with a wide selection of accessories including welders' protective clothing, headgear, slag chippers, electrode holders and ground clamps.

How production can be stepped up, products improved and fabrication costs reduced through proper applications of electronic resistance welding controls are shown in two major resistance welding displays.

Instruments and Control Devices

More than 250 different precise instruments designed to perform valuable services throughout industry and in laboratories and research centers are exhibited as are hundreds of the most modern motors and control devices, many of them functioning in a series of operating drive systems. Solutions of control problems involved in production and inspection in various industries are shown in one exhibit—an arrangement in which controls of speed, quality, tension, thickness and acceleration are demonstrated.

Officials said the company was launching the exhibit train not only because of a "natural desire to sell more G.E. products" but also for "far more important reasons having to do with our national economy and industrial well-being."

Pointing out that production of durable equipment for modernization and expansion of industry dropped from $20.7 billion in 1948 to $19.7 billion in 1949, they warned "it is high time all of us in American industry started working to reverse the trend."

The GE train is hauled by a 4500-hp., two-unit diesel-electric locomotive which pulls ten stainless steel coaches, each car being equipped with its own undercar power plant.

Expansion Joints— Their Maximum Spacing

ROBERT G. BLICK
Box 232, Sun Valley, Calif.

IT IS NOT generally appreciated that columns wherein the loads are carried by a confined fluid are identical with columns where the loads are carried by metal directly.[1] This can be logically deduced, as well as by the keen mathematical reasoning of Reference 1.

Consider Figure 1. Here the load is carried directly by metal. Since the pipe column is required to carry a load of 12,000 pounds, it would be designed so that its critical Euler column load was greater than that by some factor of safety. Assuming the ends simply supported the critical Euler load is:

$$P = \frac{\pi^2 EI}{L^2}$$

where I = moment of inertia = inches^4
L = length = inches
E = Young's modulus = psi.
P = critical load = pounds

The minimum required moment of inertia would be:

EXPANSION joints can be spaced too far apart. There are two reasons for this: 1) The rated travel of the joint may be exceeded and the joint damaged and, 2) the pipe between the expansion joint guides may collapse due to an "Euler Column" instability. Since the first item is readily cared for, this article is concerned with the instability type of failure, about which there is not too wide an understanding.

$$\pi = \frac{PL^2}{\pi EI} = \frac{12{,}000 \times 1200^2}{9.87 \times 30 \times 10^6} = 58 \text{ inches}^4$$

This can be provided by an 8 inch schedule 20 pipe, which has a 1/4 inch wall thickness. In this case the allowable load might be 3000 pounds if a factor of safety of 4 were used.

One might now contemplate Figure 2 and decide that since the load is here carried by the fluid, any kind of pipe size and thickness would do (understanding that hoop stresses would be provided for). However, *something cannot be gotten for nothing.* One could probably make many logical and correct judgments regarding natural phenomena, using such a principle, which might be likened perhaps to the first law of thermodynamics. This is true for the case in question. Since the fluid has no stiffness, *the pipe dimensions would have to be at least as good as those of Figure 1, despite the fact that the pipe itself is not under compressive load.*

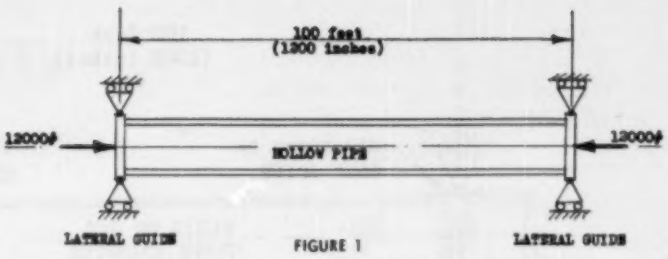

FIGURE 1

Now consider Figure 3, which is essentially identical to Figure 2, except for the omission of the "loose plugs." If the mean diameter of the expansion joint is, for simplicity, assumed to be 8 inches, a maximum pressure can be computed at which the pipe would collapse from instability. This would occur at a hydraulic end load of 12,000 pounds as in Figures 2 and 3. Letting p be the internal pressure (psi.) and D the diameter:

$$\frac{\pi}{4} D^2 p = 12{,}000 \text{ pounds}$$

$$p = \frac{12{,}000 \times 4}{\pi D^2} = 240 \text{ psi.}$$

This means that the system would collapse at pressures greater than 240 psi. If the joint were the type that has confining tension rods to prevent installation in too extended a position, a peculiar behavior might occur. With the pressure raised to perhaps 300 psi., the pipe would bow and the joints extend and draw up on the rods. This probably would not occur, of course, if the weight of the pipe acting on intermediate pipe supports developed enough friction, and the support bents possessed enough stiffness to provide lateral restraint. If the mean diameter of the joint were (as it usually is) greater than the pipe size the system would collapse under smaller pressure.

FORMULAS

Convenient formulas can be set up to define the maximum spacing for purposes of design: For pipes:

$$I \approx \frac{\pi}{8} D^3 t$$

where D may be the mean diameter
t = wall thickness

Substituting in the Euler column formula:

$$P = \frac{\pi^2 EI}{L^2} \approx \frac{\pi^2 E}{L^2} \times \frac{\pi}{8} D^3 t$$

To avoid collapse:

$$P \geq p \frac{\pi}{4} (KD)^2$$

where (KD) is the mean diameter of the expansion joint.

Substituting in this formula:

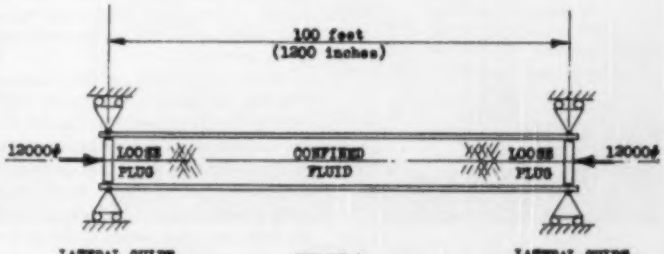

FIGURE 2

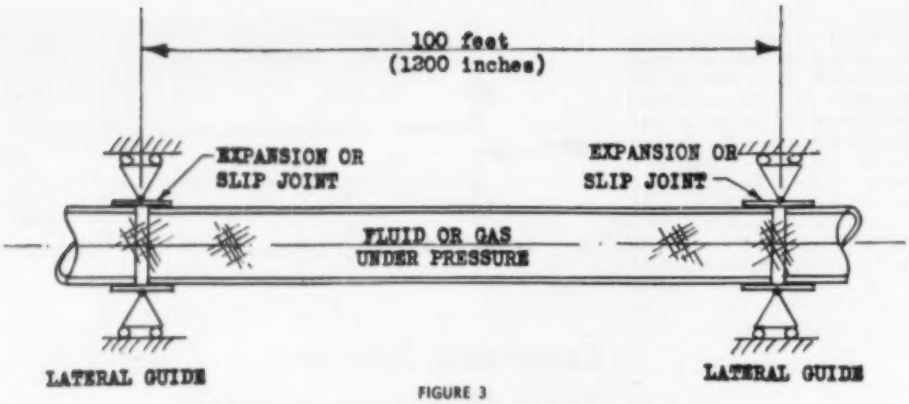

FIGURE 3

$$\frac{\pi^4 E}{L^3} \times \frac{\pi}{8} D^3 t \geq p \frac{\pi}{4} K^2 D^2$$

Simplifying:

$$\frac{pK^2}{4} \leq \frac{\pi^4 E}{8L^3} Dt \qquad (1)$$

Since pipes are generally designed by hoop tension using a formula such as:

$$t = \frac{pD}{2f} = \text{required thickness}$$

where f is the allowable stress.

this may be substituted in equation (1):

$$\frac{pK^2}{4} \leq \frac{\pi^4 E}{8L^3} D \frac{pD}{2f}$$

Simplifying:

$$K^2 \leq \frac{\pi^4 E}{4f} \left(\frac{D}{L}\right)^4$$

Rearranging:

$$\left(\frac{L}{D}\right)^2 \leq \frac{\pi^4 E}{4(K^2}$$

$$\left(\frac{L}{D}\right) \leq \frac{\pi}{2K} \sqrt{\frac{E}{f}} \qquad (2)$$

Note that pressure does not enter this formula. It may be used to select the maximum spacing of expansion joints or may be modified to select the maximum spacing between guides intermediate to joints. To apply a "factor of safety," say "F", the formula may be written:

$$\left(\frac{L}{D}\right) \leq \frac{1}{\sqrt{F}} \frac{\pi}{2K} \sqrt{\frac{E}{f}} \qquad (3)$$

EXAMPLE

As an example, assume a 12-inch pipe with expansion joints of 15 inch mean diameter. At 600° F. take *f* as 12,500 psi, and *E* as 26×10^6. Then,

$$K = \frac{15 \text{ in.}}{12 \text{ in.}} = 1.25$$

Substituting in Formula (2):

$$\left(\frac{L}{D}\right) \leq \frac{3.1416}{2 \times 1.25} \sqrt{\frac{26 \times 10^6}{12{,}500}}$$

$$\frac{L}{D} \leq 58$$

(L and D in the same units of length)

Since *D* is a foot, *L* must not exceed 58 feet, for this example. This spacing could also be used to determine the distance between intermediate guides (it could be slightly more) and the distance between joints considerably increased. It is generally advisable to guide and/or anchor at intermediate points. While there have been many systems installed and even illustrated in manufacturers' literature *that are saved only by virtue of friction at pipe supports*, some types of structural guides are definitely to be preferred. Another saving feature is the fact that generous corrosion allowances are usually associated with hot process piping. The value of *f* used in the formula might be ratioed down to include say half the corrosion allowance and all of the manufacturing tolerance as the effective thickness for stability purposes. Setting this up as a design formula to fit in with over-all Specs:

$$f = 87\tfrac{1}{2}\% \left(\frac{\text{nominal thick.} - \tfrac{1}{2} \text{ corrosion allow.}}{\text{nominal thickness}}\right) \times \text{design allowable stress}$$

where "f" is the value to be used in the formula and the $87\frac{1}{2}\%$ is to be used only where applicable.

In this example it would probably be advisable to use a spacing between guides of about 30 feet. This would give a factor of safety of about 4 or 5, assuming the pipe to have been designed to 100 percent of the allowables and taking advantage of the continuous beam effect.

While it is more or less common practice to remove expansion joints during pressure tests, that can be dangerous—certainly more dangerous than any emergencies that might arise from the tests. Pressure tests made under such circumstances say nothing about the true operating safety of the system. If a reasonable factor of safety is used in Formula 3, and if the L/D value for atmospheric *E* and the *f* that occurs under test is checked with Formula 2, no trouble will be encountered, the expansion joints may be left in the lines, and the tests give a true indication of safety. The maximum test pressure of the joint can be obtained from the manufacturer and should not be exceeded. This might be unhandy at times, since the joint may not be available at the time the pressure tests are scheduled. Also, since it is common to test lines to twice the primary service pressure rating of the fittings, which is often considerably greater than the operating pressure, the *other parts* of the line certainly receive a good test by omitting the joints (unless the joint test pressure is comparably high). But as a matter of fact, if the recommendations of this article are followed, it would then be *safe* to omit the joints, but still *desirable* to include them.

Recommendations

Various formulas similar to 2 and 3 may be derived for different end restraint conditions, to take account of intermediate guides, or where only one expansion joint is used. Alternatively, fractional multiplying coefficients may be applied to formulas 2 and 3. Some readers may care to work out the exact equations involving *I* as a term and *E* as a tangent modulus. These formulas may also be worked out for different pipe wall thickness formulas (such as are contemplated in coming revisions to the ASA Code for Pressure Piping). Simple tables can be easily devised to suit the requirements of individual design-office and company standards.

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REFINER AUTHORS and Other Personalities

Information, formal and otherwise, about the men who write for PETROLEUM REFINER as well as others prominent in the industry.

Lawyer and Engineer Team Up On Patents

SEIDEL and BONNER, a lawyer-engineer team, are authors of the article, "Inventions and Patents," Part II appearing page 115. (Part I showed up in the June issue, page 99.) Arthur H. Seidel, who holds a doctor of law degree, is a patent lawyer on the staff of Gulf Oil Corporation. Co-author and fellow Gulf Oil employe, Z. D. Bonner is chemical engineer at the Port Arthur, Texas, refinery.

Seidel was research chemist on the Manhattan Project at Columbia University and at Oak Ridge, Tenn., and has been with Gulf Oil since 1947. Besides his doctor's, which he received from George Washington University in 1949, he holds a B.S. in chemistry from the College of the City of New York and a M.S. from the University of Michigan. From 1945 to 1946 Seidel was a graduate teaching assistant in chemistry at the State University of Iowa. A member of the honorary legal fraternity, Order of the Coif, and Nu Beta Epsilon legal fraternity, Seidel was a former editor of the George Washington Law Review. He is on the Attorney's Roster of the U. S. Patent Office and is a member of the District of Columbia Bar.

Bonner was graduated in 1941 from the University of Texas with a B.S. in chemical engineering and is a member of Tau Beta Pi, Phi Lambda Upsilon and the American Chemical Society. Except for several years with the Navy, where he served as lieutenant commander, Bonner has been continually with the Port Arthur refinery. Called to the Navy as ensign, he was in charge of petroleum inspection for the Chicago Naval Inspection District, which covered the Middle West. Upon returning to the refinery after the war, Bonner worked on light oil treating and later in the technical service division. In 1949 he was sent to the Patent Office of Gulf Oil in Washington for training in Patent Law.

Engineer's Hobbies Flying, Photography

"CORROSION Resistant Liners in Refinery Vessels and Equipment," starting on page 95 of this month's PR, was written by G. C. Carpenter, equipment inspection department, Esso Standard Oil Company, Louisiana Division, Baton Rouge. Carpenter is a Virginian, hailing from Louisa County, where he was born in 1919.

In 1936, Carpenter enrolled in the engineering school of the University of Virginia, but unable to solve some complex problems in finance found himself looking for a job before the sheepskin came within reach. He went into sales work, which occupied him for four years. This work he followed with five years of military service. (He is now active in the air force reserve.)

Carpenter again entered Virginia U. in 1946 and two years later had his degree in mechanical engineering. Since July, 1948, he has been in the equipment inspection department of the Baton Rouge refinery. His duties have included metallurgical, corrosion, and paint studies, and unit inspection.

As evidence of his interest in photography, he is past president of the Baton Rouge Camera Club and Editor of "Lights and Shadows," the club's magazine. Favorite subjects are landscapes and daughters, Nancy, age 4, and Carolyn, 1 year old. Fortunately, he says, his enthusiasm for picture-taking is shared by his wife.

Carpenter is active in the New Orleans section of ASME, chairman of the technical program committee for the forthcoming 1950 ASME Petroleum Conference, and is a volunteer worker with local civic groups.

Treating Engineer Has Naval Background

L. W. ZAHNSTECHER, author of "Liquid Phase Hydrogen Removal," page 107, was graduated from City College of New York, in 1941 with a B.Ch.E. degree. The following two years were spent with Blaw-Knox in the training program, gas treating section, chemical division, and metallurgical division. He was commissioned in 1943 as a Naval steam engineer and was assigned as a diesel engineer, serving on a mine sweeper for two years. In 1945 he attended the Annapolis post-graduate school, graduating with an M.S. degree in chemical and explosion engineering from Cornell University in 1946.

In that same year Zahnstecher became associated with Foster Wheeler Corporation, where his work included process engineering in petrochemicals and chemical treating units. At present he is in charge of the treating section of the petroleum division.

Zahnstecher classes himself as an enthusiastic but inexpert photographer with his most pleasurable hobby being the rearing of two daughters.

CPA Sets Up Cost Analysis Budget

JOHN L. FOX, whose article "Cost Analysis Budget to Evaluate Operating Alternatives for the Oil Refiners," starts on page 90, was born in 1926 in the oil refining community of Emlenton, situated only 30 miles from the site of the first commercial oil well at Titusville, Pa. He is now a staff member of a national firm of certified public accountants.

After completing his high school work in Emlenton, Fox entered Villanova College, then Muhlenburg College as

G. C. CARPENTER

A. H. SEIDEL

Z. D. BONNER

CECIL H. HALE

L. W. ZAHNSTECHER

JOHN L. FOX | E. E. DONATH | E. L. FRESE | L. C. SKINNER | JOHN C. ALBRIGHT

an engineering student. At Muhlenburg he shifted from engineering to business administration studies with an accounting major. Under the Navy's R.O.T.C. program he was assigned to Duke University and was graduated in 1947 with an A.B. degree in business administration. The graduate division of Wharton School of Finance and Commerce of the University of Pennsylvania at Philadelphia in June, 1949, awarded him a master's degree in business administration. Here he also received the Adam Averill Ross prize for his thesis, on which his article in this issue of PR is based. While at Penn, he also stressed studies in industrial management.

Fox says he is too busy to develop many extra-curricular interests; however, he maintains a devotion to swimming cultivated during summers spent at Ocean City in New Jersey. He is a member of Lambda Chi Alpha fraternity, a 32nd degree Mason and a Shriner.

Doctors Collaborate On Polarography

DR. CECIL H. HALE is co-author with Dr. Philip W. West of the article, "The Application of Polarography in the Petroleum Industry," which appeared, page 109, June PR. Dr. Hale's background, full details of which were not available for last month's use, centers around service with the Esso laboratories of Esso Standard Oil Company, Louisiana Division, at Baton Rouge.

After graduating from Trinity University (Texas) in 1938 and receiving a M.S. degree in chemistry from Louisiana State University in 1940, Dr. Hale worked in Esso's analytical department at Baton Rouge. In 1945 he left for Purdue University on a leave of absence and in the same year married a fellow chemist. Upon receiving his Ph.D. degree from Purdue, he returned to Esso.

Since marriage, Dr. Hale says his interests have been domesticated from chess and tennis to bridge and yardwork.

Gulf Oil Executive Retires

After 35 years with Gulf Oil Corporation and its affiliates, E. C. Bothwell, a director and production vice president, has retired. Dr. K. C. Heald was elected a director to succeed him.

Two Europeans on Technical Quartet

A BUREAU of Mines quartet, consisting of engineers and chemists at the coal-to-oil demonstration plant at Louisiana, Mo., authored the article "Residual Oil Hydrogenation," page 83. L. C. Skinner, E. E. Donath, H. Schappert, and E. L. Frese, each make his first appearance in this issue.

Skinner, a native of Bartlesville, Okla., began with the Bureau in early 1946 first as process engineer and later as chief of the engineering and design section. Skinner was responsible for supplying all basic process data and design information for the plant in Louisiana, Mo. Previous experience was six years with Phillips Petroleum Company, mostly at the Borger refinery in Texas. Here he served in various positions including design engineer and chief estimator. While with Arthur G. McKee Company he was a piping squad leader and design engineer, later serving as chief engineer with Ashland Oil & Refining Company, Catlettburg, Ky. Skinner holds a B.S. degree in chemical engineering from Kansas State College.

Dr. Donath, in the United States since 1947, was born in Sternberg, Czechoslovakia and received his higher education from the Technical University at Breslau where he studied chemistry and specialized in physical chemistry. Dr. Donath joined the Badische Anilin und Sodafabrik at Ludwigshafen, working as chemist, group leader, and chief chemist in research under the internationally renowned Dr. M. Pier on the coal hydrogenation process. Dr. Donath first came to the U.S. as a scientific advisor to the War Department. He has also worked with the Bureau in California.

Also from Europe is **Dr. Frese** who was born in Korbach, West Germany. He has been in the U.S. since 1946. At the University of Marburg he studied chemistry, physics and mineralogy, obtaining a Ph.D. degree in 1924. For two years he was special assistant to the director of the chemical institute working in research of organic chemistry. In 1926 he entered the I. G. Farbenindustrie, Plant Ludwigshafen-Oppan, Rhein, as chemist, in the development of processes for synthetic lubricating oils and plastics and from 1927-1937 was with an affiliate plant at Leuna, Middle Germany. In 1937 he became deputy director of the newly erected hydrogenation plant, Ruhroil, Bottrop, Hugo Stinnes Werke, West Germany, where he was later named general manager and director. Dr. Frese lists non-professional interests in the field of sports, mainly skiing and tennis.

Biographical data on H. Schappert, the fourth collaborator of this article, were not available.

Process Outlined By Free-Lance Writer

A LONG-TIME contributor to PETROLEUM REFINER and other oil publications (See "Design and Operation of Kettleman Hills Gas Mixing Station," July, 1935, PR), John C. Albright again comes into view with his latest contribution, "Process Gives Plant Water Free of Scale and Corrosion," page 119. Albright started out as an oilman in 1910 swinging a 16-pound sledge to dress out a bit on a string of standard tools near Burkburnett, Texas. From tool dresser through various jobs as driller and tool pusher—with a hitch in the "Wind Service" in World War I at Call Field—Albright changed into natural gasoline. Working over Texas, Oklahoma, and New Mexico for Phillips Petroleum Company, he helped in the making of casinghead gasoline.

Starting out as a free-lance journalist, he claims to have covered practically every phase of the oil industry. Albright was selected as special consultant on the Bureau of Mines section dealing with technical advances in refining, which was published in Report No. E-19, July, 1939.

Albright now lives in Santa Monica with his wife, Lucile, and two sons, both of whom are veterans of World War II and now in college. As assistant to his wife, he shares in her national fame as collector of rare, antique buttons. His wife is a recognized authority on this unique hobby and is sometimes referred to as the "dean of button collectors." John, himself, rates "dean" in many an editor's book.

Research Engineer Has Varied Record

R. J. S. PIGOTT, contributor of the article, "Compression Ratio, Octane Demand, and Lubrication," page 111, can boast a record of 30 patents on power-

QUITE a number of years ago Revere coined the phrase "Bubbles have teeth." This refers to the fact that what is called air entrainment is highly damaging to condenser tubes. Bubbles carried along with the cooling water set up a strong disturbance in it, disrupting the film that should protect the metal, and actually seeming to eat away the tube. The oxygen contained in the air bubbles also is destructive. Fortunately, the effects of air entrainment on condenser tubes are sufficiently distinctive to permit Revere Research to detect the trouble by examination of short lengths cut from tubes that have failed before their time.

Thus it happens that every once in a while the Research Department in Rome, New York, working through the Technical Advisory Service, is able to say that there is air leaking into a condenser it has never seen, in a far-off state. The problem then is to seal the water system against the entrance of air. This is not always an easy task, and it is one that the Revere Technical Advisory Service is glad to tackle together with the customer if asked to do so. After all, we want our condenser tubes to last as long as possible; that's what makes customers happy, and builds and preserves our reputation as producers of fine tubes.

In one such instance of bubble trouble, the operator, a public utility, could find no visible sign of a leak. Checking and tightening every bolt and seal produced no results. Finally it was decided to put plate glass windows in some of the inspection plates, in order to see what was going on inside. This located the defect, a stream of bubbles being easily seen pouring out of a gasket. The water was flowing past that gasket with sufficient velocity to suck air in.

In another instance, a few samples of failed tubes from an oil refinery (located almost 3,000 miles away from the utility) were sent to Revere's Research Department. The refiner was told that his trouble was due to bubbles. Again, a check of the condenser showed nothing. The water inlet and outlet lines and all gaskets and bolts seemed to be perfectly tight. Here was another puzzler. But once again it seemed plausible to assume that air was being drawn in where water velocity was high enough to create a suction. The search finally went all the way back to the water pumping station, where two cracked castings were located. Air sucked in through two tiny cracks was enough to do a lot of damage; bubbles do indeed have teeth.

Revere will gladly consult with you concerning condenser tubes, their selection, specification, and conditions of use. For condenser tubes and tube sheets in all the usual alloys, see Revere.

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plant equipment, oil burners, meters, test equipment and pumps, and more than 40 technical papers on power-plant design, fluid flow, instruments, lubrication, fuel and lubrication systems in aviation, and superchargers. A previous contributor, Pigott's "Fuel Sources in Event of Petroleum Scarcity and Cost Increases," was published by PR last February.

At present Pigott is chief engineer for Gulf Research and Development Company, Pittsburgh. He was 1949 president of the Society of Automotive Engineers. His experience includes consulting engineer in the construction of power and service equipment for Remington Arms, superintendent of mills for Bridgeport Brass Company, and works manager of Crosby Steam Gage and Valve Company. In 1922 he returned to the power industry as mechanical engineer at Stevens and Wood. Later he designed and constructed large power plants for Public Service Production Company. Since 1929, Pigott has been chief engineer for Gulf Oil Corporation and its subsidiaries.

Professor at Columbia

After graduation in 1906 with a degree in mechanical engineering from Columbia University, he engaged in power-industry installing of low-pressure turbines and other equipment, and in the reconstruction of several electric power generating plants in the East and middlewest. He returned to Columbia for one year's professorship of steam engineering.

Pigott was the first president of the former American Society for Measurement and Control, now the Pittsburgh Chapter of the Instrument Society of America. He was also chairman of the ASME special research committee on fluid meters from 1916 to 1946, and from 1918 to 1946 was a member of ASME main power test codes subcommittee.

Currently Pigott is serving this year as president of the Instrument Society of America.

R. J. S. PIGOTT

Pacific Gas and Electric Head Joins Shell Board

James B. Black, president of Pacific Gas and Electric Company, has been elected a director of Shell Oil Company, raising the number of Shell directors to 20. Black, a 1912 graduate of the University of California, has been vice president of Western Power Corporation and vice president of The North American Company. He is a director of Southern Pacific, United States Steel, Equitable Life Assurance Society of the United States and several other companies. Black also serves as consulting professor of public utility management in the graduate school of business at Stanford University and is a member of the advisory council, school of business administration, University of California.

Cities Service Posts Go to Harris Bateman

Harris Bateman of New York has been named chief engineer for Cities Service Oil Company (Delaware) and Cities Service Pipe Line Company as well as a director of Cities Service Oil Company. Bateman was before coordinator of purchasing at the New York headquarters of Cities Service.

He was first employed in the engineering department of Cities Service at Bartlesville, Okla., in 1927 upon graduating in civil engineering from Oklahoma A. & M. College.

UOP Research Director To Speak in Europe

Dr. Gustav Egloff, director of research, Universal Oil Products Company, Chicago, is on a trip to Europe where he will address various technical groups in Glasgow, Scotland; London, Paris, Milan, and Rome. He is expected to return to the U. S. about August 6.

Continental Picks Directors

H. Gardiner Symonds, president of Tennessee Gas Transmission Company, Houston, and W. C. MacMillan, executive vice president of Continental Oil Company, Ponca City, Okla., have been elected to the board of Continental.

McClanahan New Director

E. J. McClanahan has been named to the board of directors of Standard Oil Company of California. McClanahan has been a vice president since 1943, specializing in marketing activities. He joined the company in 1912.

* * *

ORC UNIT ACTIVATED

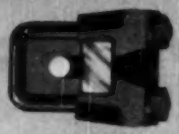
The 889th Quartermaster Petroleum Depot Company, an Organized Reserve Corps unit sponsored by Standard Oil Company of California was activated recently at ceremonies in San Francisco.

The activation ceremonies included talks by Colonel James Notestein, Sixth Army Information Officer, and W. W. Davison, Standard vice president. Colonel Otho W. Humphries, Sixth Army Quartermaster, presented the company's commander, Captain Lawrence G. Miller, with the guidon for the organization.

Also present at the ceremony were Second Lieutenants John T. Blodgett, C. L. Radcliff and William A. Vandervort of the new ORC company, as well as other Standard officials and officers of the Sixth Army Quartermaster section.

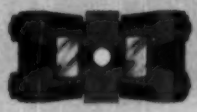
* * *

REFLEX

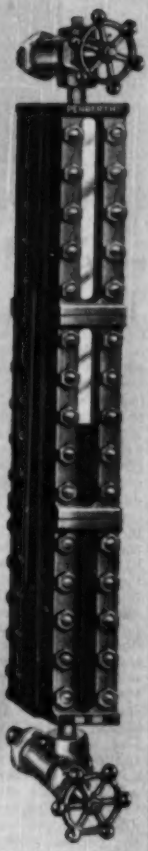


Shows empty space white—liquid black by means of a simple, unvariable optical principle. Read it accurately as far as you can distinguish black and white.

TRANSPARENT



Used to observe color and density of liquids under high pressures and/or temperatures. Exceptionally sturdy construction—liquid chamber machined from solid block of metal.



PENBERTHY LIQUID LEVEL GAGES *Meet All Oil Industry Needs*

Penberthy Gages are made in a wide variety of types and sizes to meet all liquid level gaging needs in the oil industry. Four popular models are shown here. Many others (both standard and special) are available to suit all conditions of pressure and temperature. Penberthy Gages are built to the most rigid standards of quality and have the highest reputation in the oil industry. Conform with API-ASME Standards.

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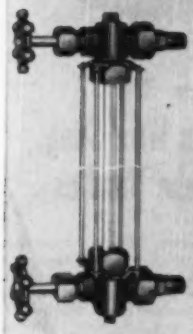

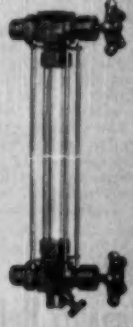

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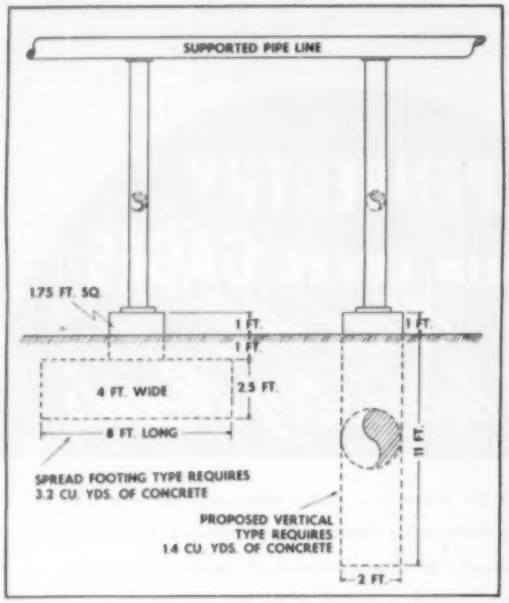
Maintenance and Operation

HOW TO DO IT

HOW TO—Lower Pipe Support Foundation Cost

THE foundation for an individual overhead pipeline support is not an item of high cost in the construction of process plants. However, the large number of such foundations required for a plant does represent a construction cost in time and materials. In the sketch are shown two types of foundations universally used for pipe supports. The sketch illustrates the savings in time and materials of a vertical cylindrical foundation over the spread footing type. Use of the spread footing type foundation is sometimes advantageous due to soil bearing conditions; however, the vertical type is often most economical, requiring less concrete, and having a lower installation cost.



Usually, more excavation and more concrete is required for the spreading foot type foundation. In the typical case illustrated, the pad is 8 feet long, 4 feet wide, and 2½ feet thick. Also, the top of the footing is one foot below grade level and requires an additional block of concrete 1.75 feet square and 2 feet high. It contains 3.2 cubic yards of concrete.

The vertical cylindrical foundation of similar load carrying ability is 2 feet in diameter and 12 feet in over-all height, containing only 1.4 cubic yards of concrete. It should be noted that a portable excavation drilling rig can be justified when a large number of holes are required for this type foundation.

Formulas for determining length and bending moment for steel H-beams and steel sheet piling as covered by the manual "Steel H-beams and Steel Sheet Piling Used as Cantilevers in Soil," issued by United States Steel Corporation, can be used for calculation of foundations of this type.

Sketch and material courtesy of "Coin Your Ideas" Committee, Esso Standard Oil Company, Louisiana Division, Baton Rouge. Suggestion submitted by James O. Terry, designing draftsman, mechanical engineering department.

HOW TO—Simplify Refinery Tower Assembly

A 25-TON section of the atmospheric fractionating tower, pipe still No. 1, in the new Esso refinery at Fawley, England, is shown in the photograph. The section is being lowered into position for welding to the base section.

The section was fabricated on the ground, scaffolding brackets and safety rails being attached and board walkways laid inside and out. The threaded-rod spider, which can be seen in the lower end, stiffens the vessel section and provides a means for aligning the edges for butt welding to the base section. After the two sections have been welded together, access to the tower inside and out will be much easier for workmen installing trays, piping, insulation, etc.

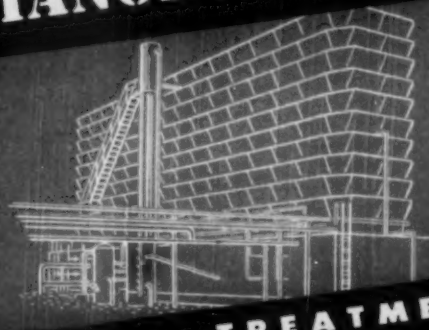
The job of attaching the scaffolding brackets, spider, and walkways was a much simpler and faster operation at ground level, than it would have been after the section was lifted in place and welded. Safety considerations required that the scaffolding be firmly fixed in place during and after the lifting operation, of course.

HOW TO—Use Woven Wire Sling To Lift Tube Bundles

WOVEN wire slings, constructed from an adaptation of the basic mesh used in the fabrication of woven wire conveyor belts, are being used for handling heat exchanger tube bundles, rod and bar stock, and pipe and cylindrical tanks. The sling, shown in use lifting a tube bundle by a choke hitch in the photograph, has special tempered steel handles. They are attached to both ends of the sling to permit use of either a choke or basket hitch around the material.

The slings are made of woven wire in standard widths of 3 inches to 30

NEW DIANODIC METHOD OF COOLING WATER TREATMENT



Here's an entirely new approach for the prevention of corrosion, pitting and scale in cooling water systems. The dianodic method was developed in the research laboratory and proved in the field. Amazing results are obtainable—Freedom from Scale, Protection against Corrosion, and ELIMINATION OF PITTING AND TUBERCULATION.

Basically, the dianodic method consists in employing a combination of two anodic inhibitors in such a manner as to produce results superior to either inhibitor singly—*even in high concentrations.* With the proper use of conventional inhibitors it is possible to obtain good overall corrosion protection, but localized corrosion may continue to occur in the form of pitting. In these areas of concentrated attack, corrosion may be accelerated so that metal failure is almost as rapid as without any corrosion inhibitor. The new dianodic method gives equal or better protection from the standpoint of general corrosion and ELIMINATES PITTING AND TUBERCULATION.

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inches, and from 36 inches to 132 inches, standard lengths. Slings are available in any metal or alloy, including stainless steels.

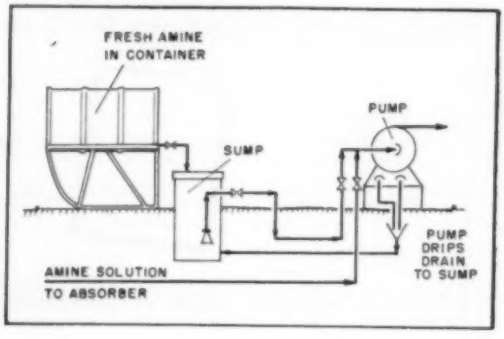
Width and cross rod construction of the sling provides better gripping power than a wire line or rope sling; consequently, there is less danger of the material being handled slipping. This factor increases worker safety. Also, since the woven wire will bend around an extremely small radius and does not kink or tangle, it is easier to handle than other types of slings. (Material and photo courtesy Cambridge Wire Cloth Company, Cambridge, Md.)

HOW—Makeup Solution Is Added to System

ADDING makeup diethanolamine solution to the circulation system of an H_2S gas treating unit is accomplished by the use of simply designed, inexpensive equipment directly from the original shipping container. A sled-type drum stand is used so the solution can be withdrawn easily from the container.

Sunk into the ground near the circulating pumps is a small steel tank which serves as a suction tank and as a drip collector for waste from the pump rod packing glands.

When fresh solution is added to the system the dust-tight cover on the suction tank is removed, and the tank filled by an operator with the desired amount of amine from the container on the sled-type drum stand. Suction is obtained through a vertical pipe, fitted with a foot valve, leading from the process pump suction manifold to the suction tank. A gate valve on the suction line near the solution tank makes it possible for the operator to make the transfer quickly and without loss of chemicals.



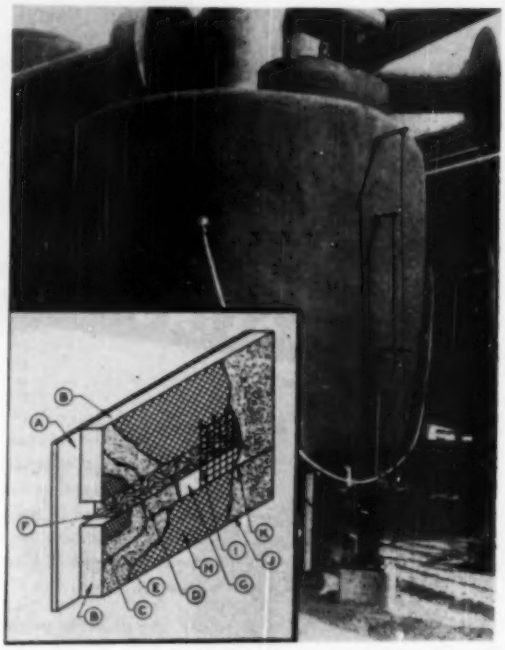
HOW TO—Provide Insulation Expansion Joints

DURING initial heating or shutdown of large heated metal vessels—boilers, tanks, towers—appreciable expansion or contraction occurs. As a result, insulation on large surfaces will crack and buckle unless precautionary measures are taken. Expansion joints can be designed to permit the insulation layer to expand and contract with the metal surface.

Horizontal expansion joints should be provided at 12 to 16-foot intervals on equipment operating above 600° F. These joints consist of 1½ to 2-inch wide furrows of loose mineral wool, covered with protecting flaps of galvanized hardware cloth, between adjacent blanket edges.

The diagram shows the sequence of application of materials from A to I. The width of the mastic and rosin paper strips, D and G, adjacent to the cleavage side of the furrow, is 4 inches. The bottom edge of the hardware cloth flap I is left free to move up or down as the metal surface expands or contracts.

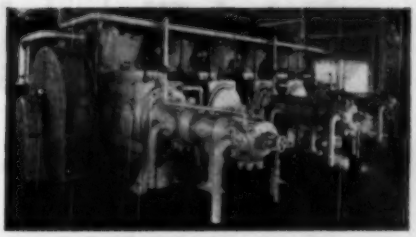
After asphalt weatherproofing mastic J is trowelled over the isulation, a line of cleavage K is struck at the lower edge of each expansion flap with the point of a trowel. Material and photograph courtesy of Industrial Mineral Wool Institute, 441 Lexington Avenue, New York.



Recommended method for installation of mineral wool insulation expansion joints is shown at the right. In the drawing, A is the heated surface, B mineral wool insulation, C first ¼-inch layer of insulating cement, F loose mineral wool fill, G rosin-sized paper, H is 1-inch galvanized wire mesh, I is 12-inch wide strip of 1-inch galvanized hardware cloth, J asphalt base, and K line of cleavage.

At Sun Oil's Starr County Plant . . .

A 4-WAY JOB FOR MODERN COOPER-BESSEMERS



This 10-cylinder, 1100 hp GMV Turbollow compressor, known for extreme compactness and over-all operating economy, compresses residue gas from 1,000 to 2500 psi for return to field reservoir. Automatic control maintains constant pre-set discharge pressure.

This line-up of Cooper-Bessemer gas engines in generating plant consists of four 600 hp, 8-cylinder JS's driving Ideal 400 kw generators and three 280 hp, 8-cylinder Type GS engines driving Ideal 200 kw generators.

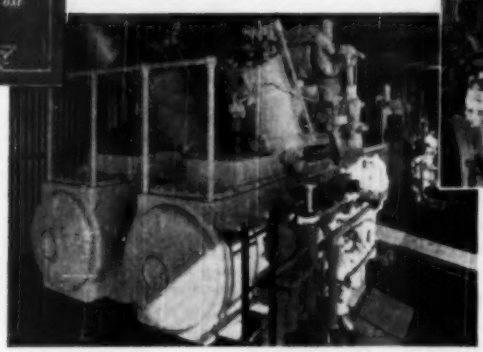
Exterior of generator building showing muffler, air filter and oil cooler equipment.

In this new natural gasoline plant, engineered by Petroleum Engineering, Inc., there's good evidence of how well, how efficiently Cooper-Bessemer units of various types meet today's needs in power, compressing and pumping.

For in this one modern project, as shown here, you'll find Cooper-Bessemer in-line gas engines driving generators for all electric power requirements. And you'll find space-saving Cooper-Bessemer Twin-line pumps handling lean oil. These pumps in turn are direct-driven by compact Cooper-Bessemer GMX V-Type gas engines. Finally, last but not least, a 1,100 hp Cooper-Bessemer GMV Turbo-flow, tops today in compressor compactness and over-all economy, handles residue gas for return to a field reservoir.

To get at the reason *why* Cooper-Bessemers have been picked for all these services, you have only to weigh the important new developments introduced during recent years by one of America's *oldest* builders of engines and allied machinery.

Another Example of Efficient Power at Lower Cost



Two Cooper-Bessemer GMX-4, V-Type gas engines, each direct-driving a Twin-line 6-cylinder lean oil pump through fire wall. Each GMX is rated 200 hp at 400 rpm.

One of two Cooper-Bessemer Twin-line lean oil pumps in Sun Oil Starr County plant. High pressure side (foreground) is designed to operate on 41 API gravity lean oil, from 220 to 1100 psi while handling 248 gpm. Other side, in series, operates from 20 to 225 psi while handling 388 gpm.

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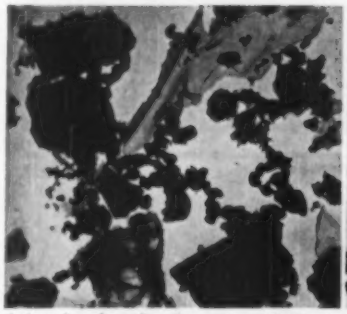
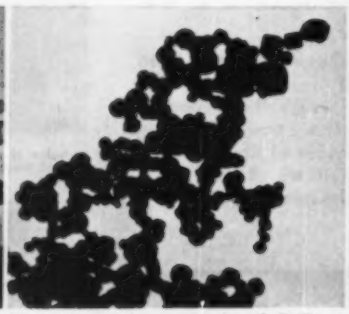
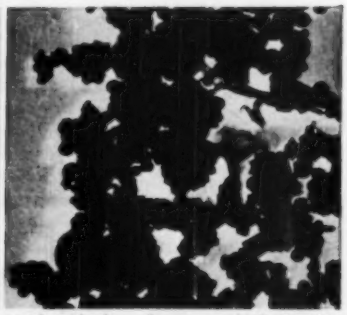


Activated carb..n dust from rotary dryer. P-A Venturi Efficiency **98%**



Iron oxide dust from oxygen-lanced open hearth. P-A Venturi Efficiency . **99%**



Lead oxide fume from scrap lead blast furnace. P-A Venturi Efficiency . **95%**

The Electron Micrographs above show the type of dust particles the Chemico P-A Venturi Scrubber removes almost completely from industrial gases. Equally important, the price of efficient P-A Venturi performance is *low* . . . in initial cost of the equipment, in maintenance and water requirements.

For gas scrubbing, for recovery of valuable metals and chemicals or for absorption of odors, it will pay you to investigate the Chemico P-A Venturi Scrubber.

NEW 8-PAGE BULLETIN

Fully illustrated Bulletin M-102 gives performance data and case histories on both the Chemico P-A Venturi and Cyclonic Gas Scrubbers.

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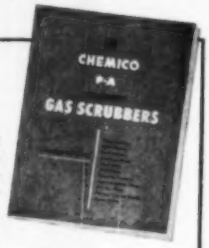

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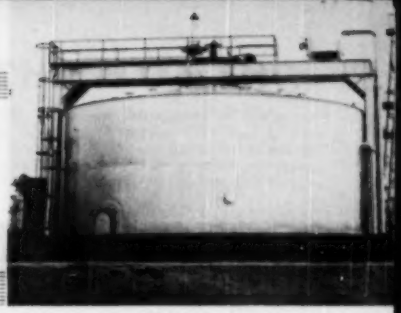
Chemico Plants are Profitable Investments

The MONTH... in the INDUSTRY



ELEVATED DE-SLUDGE TANK—A special elevated de-sludging tank, designed and fabricated by American Pipe and Steel Corporation, now in use at the Union Oil Company's Santa Fe Springs operation, is pictured here. The de-sludger, requiring specialized engineering of supports and foundations, consists of a 40' diameter, 18' shell, welded steel tank mounted 7' above the ground. The bottom of the tank is of cone shaped construction with a Dorr classifier to sweep the sludge which settles during processing. A screw conveyor then pulls the sludge out of the tank and deposits it. Corrosion is minimized in the unit through a complete cathodic protection system.

API Survey Shows 1949 Best Safety Year

The petroleum industry established an all-time safety record in 1949 according to the annual summary of injuries compiled by the Department of Safety of the American Petroleum Institute. The study was based on the experience records of 263 oil companies employing 478,583 persons. Total exposure exceeded one billion hours.

The frequency rate of injuries in 1949 dipped to 10.54 per million man-hours worked, and the severity rate of injuries declined to 1.03 days lost per thousand man-hours worked. This represents an improvement of 14 percent under the 1948 frequency rate, and 11.2 percent under the 1948 severity rate. The average employe is now three time safer at work than at home, as shown by API comparative figures.

Chances of an employe being injured fatally now are almost 4400 to 1, against an average of 2800 to one in 1946, according to the survey, which also estimates chances of an employe being disabled by injury are 45 to 1, compared with 34 to 1 four years ago.

U. S. Steel Comptroller Sounds Pension Warning

Pensions, by their nature, are arrangements which cover the life spans of individual men and women and reach out even beyond that when groups of men and women are concerned, and accordingly, it is the accountant's responsibility to point out to management the extent of the true cost of any proposed pension plan over a long period of time. This is the belief of Robert C. Tyson, comptroller of United States Steel Corporation. Tyson addressed the National Association of Cost Accountants last month in New York.

"When historians of the future write our history for the first half of the twentieth century, they will undoubtedly say that it went out in a blaze of welfare, security and deficit financing," Tyson said. "The opportunity and obligation of the accountant is to make sure that the brightness of the blaze does not blind us to the danger of the fire."

Pittsburgh Conference On X-Ray Diffraction

The eighth annual Pittsburgh conference on X-ray and electron diffraction will be held November 2 and 3 at the Mellon Institute for Industrial Research. "European Advances in High Intensity X-ray Diffraction" is a talk to be given by Professor Andre Guinier. Other sessions will have papers on small-angle scattering, instrumentation and techniques, applications in the fields of metals and silicate chemistry, and general subjects.

Papers should be sent to the chairman of the program committee, Dr. L. J. Hofer, Bureau of Mines, Bruceton, Pa., before August 15.

Shell Development Reorganizes Research

Research and development activities of Shell Development Company at Emeryville have been reorganized. Appointed associate directors of development are B. M. Beins, mechanical engineering; C. L. Raymond, process engineering; M. Souders Jr., chemical engineering; and D. L. Yabroff, process development.

Others named are C. R. Nelson, department head of process engineering with A. J. Cherniavsky and G. E. Liedholm as assistant department heads; G. A. Nelson, staff metallurgist; W. E. Hand, head, costing and appraisals; P. D. Hishon, chief draftsman, development; and P. R. Hoyt and M. V. Long, staff consultants, instrumentation. D. J. Pompeo will head a new department consolidating the instrument research and development groups of the company.

T. W. Evans, director of research, is head of the research division with A. J. Johnson, vice president and director of development in charge of the development division.

H. E. Randlett Jr. is administrative assistant to the director of research.

Plant Fungicide Offers Plant Disease Weapon

Described as the nearest approach yet to a universal weapon against plant disease, SR 406, a new fungicide developed by Standard Oil Company (New Jersey) in cooperation with Rutgers University, is said to be effective in controlling fungus diseases and is non-injurious to plants. It has proved especially valuable in combating apple scab, brown rot of peach, early blight of tomato, late blight of potato and leaf spot and brown rot of cherry. Manufacture and distribution of SR 406 will be handled by The California Spray-Chemical Corporation.

Re-elected President

C. E. Streeter, Bradford, Pa., oil producer, has been re-elected president of the Pennsylvania Grade Crude Oil Association. New directors are James A. Upham, Mt. Vernon, Ohio, independent producer and president of the Ohio Oil and Gas Association; G. H. Osborne, Kendall Refining Company, Bradford; and C. F. Felton, Franklin refinery, L. Sonneborn Sons, Inc., Franklin, Pa.

Wide Variety of Topics Given at Technical Meet

Future plans were the principal topic of discussion when 225 key technical men from Standard Oil Company (Indiana) and its subsidiaries met at French Lick late in May for the company's Eighth Joint Technical Meeting. Considered were such matters as methods of making new chemicals from petroleum, patent trends in the oil industry, and the place of technical men in public relations activities.

In all, 73 papers were presented. At a dinner on Monday evening, the scientists heard a talk by Charles A. Thomas, executive vice president of Monsanto Chemical Company and former president of the American Chemical Society, on the subject "Some Random Thoughts on Research Administration." (See page 59 for more complete report.)

Most of the papers dealt with methods of making improved fuels and lubricants. Among the developments discussed during the week is a new cracking catalyst, described by W. R. Hertwig. The catalyst is of the silica-alumina type, but is superior to present commercial catalyst because it maintains its activity longer in service.

An improved detergent additive for lubricating oils was reported by L. W. Mixon. The new additive is particularly helpful with diesel fuels that are high in sulfur content and so require special lubricants.

A fundamental study of the nature of color bodies that may occur in catalytically cracked petroleum distillates was reported by R. H. Brown. It was found that the yellow substances present in freshly cracked products are apparently hydrocarbons of the fulvene type. The colored materials that form on storage proved to be organic compounds containing oxygen, sulfur, and nitrogen. Presence of four different types of material was found to be requisite for formation of gum, color, and sediment;

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these four necessary ingredients are oxygen, thiocresols, nitrogen compounds, and a fourth unidentified factor.

Latest steps in the change of grease-making from an art to a science were reported by G. V. Browning, who described electron-microscope studies of grease structure. It was found that the oil in a grease can be extracted without changing either the microscopic or macroscopic structure of the soap fibres. This technique greatly facilitates study of structure, and also makes it possible to replace the oil originally present in the grease with other liquids, for example silicones, which cannot readily be incorporated in greases by direct methods.

Improved scientific methods are also being used to guide utilization of industrial asphalts, it was pointed out by F. H. MacLaren. This widely used natural plastic is selected at present on the basis of rule-of-thumb appraisal. Current specification tests of softening point, penetration, ductility, and viscosity are inadequate to evaluate asphalt performance, Mr. MacLaren pointed out. New refinitive performance tests have therefore been developed. They measure bonding strength (cohesiveness), flexibility, brittleness, and performance under torque. Additives for improvement of these properties are under development.

Growing use of the mathematical technique of statistical analysis in the planning of laboratory and pilot-plant experiments was described by P. C. White. Such analysis determines the contributions of a number of variables, and so permits several variables to be changed simultaneously, with a consequent reduction in the number of experiments that must be performed. Statistical analysis is also finding increased use in the planning of plant control tests and in the study of factors affecting the operation of plant equipment, Dr. White said.

NPC Committee Investigates Synthetic Fuel Cost Data

Investigation of government estimates of the cost of producing synthetic fuels has been assigned to a 12-member committee of the National Petroleum Council, with W. S. S. Rodgers (Texaco) as chairman. Appointed at the request of Interior Secretary Oscar Chapman, the committee will also seek to develop independent industry cost estimates and make recommendations as to ways in which cost figures published by the Bureau of Mines might be improved.

Other members include K. S. Adams, Phillips Petroleum Company; Hines H. Baker, Humble Oil & Refining Company; Max W. Ball, oil and gas consultant; Bruce K. Brown, Military Petroleum Advisory Board; Robert L. Foree, Texas Independent Producers and Royalty Owners Association; John M. Lovejoy, Seaboard Oil Company of Delaware; R. S. Shannon, Pioneer Oil & Refining Company; Reese H. Taylor, Union Oil Company of California; J. Ed Warren, Independent Petroleum Association of America; L. S. Wescoat, The Pure Oil Company, and Robert E. Wilson, Standard Oil Company (Indiana).

Bill Offered to Extend Synthetic Fuels Research

Legislation to extend the Interior Department's synthetic liquid fuels research program for another three years past present termination date of April 5, 1952, has been introduced in Congress by Chairman Peterson (D. Fla.) of the House Public Lands Committee, acting on recommendation of Interior Secretary Chapman. It was referred to Peterson's committee.

The bill would authorize an additional $25,000 in funds. The present program was established in 1944 and a total of 60 million will have been spent by April of 1952. Chapman urged continuation of the program on grounds that "further technological and scientific research is required to demonstrate the commercial feasibility of the processes" of converting coal and oil shale into liquid fuels.

The MONTH...

New Equipment Cuts Shale Mining Costs

Recent developments in mechanized mining at the U. S. Bureau of Mines oil-shale mine near Rifle, Colo., have lowered mining costs to 29 cents per ton of shale, according to E. D. Gardner, chief mining engineer, Bureau of Mines, and E. M. Sipprelle, chief of the Oil Shale Mine Branch at Rifle. This is considerably less than previous estimates and includes production rates of 148 tons per man-shift underground labor and 116 tons per man-shift total labor.

Boyd Guthrie, chief of the Oil Shale Demonstration plant at Rifle, and Lester W. Schramm, chemical engineer at the plant, said the cost of producing crude shale oil from 30-gallon-per-ton-shale, using the new mining and processing techniques, would be about $1.50 per barrel. This included estimated out-of-pocket operating costs and depreciation

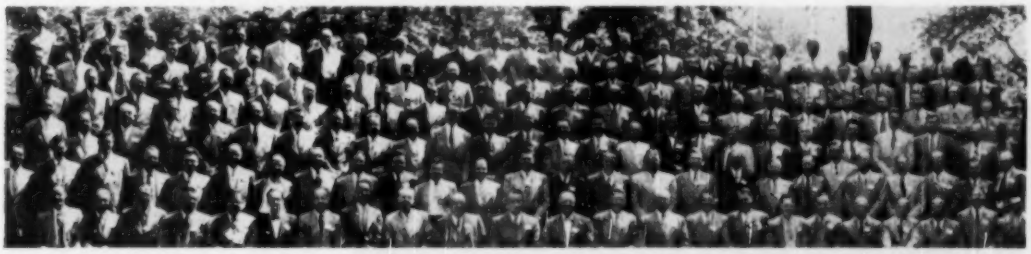


Photo taken at eighth joint technical meeting, Standard Oil Company (Indiana) and subsidiaries held in May at French Lick. All shown are from Indiana Standard except those marked with I (Indoil Chemical Company), PAS (Pan-Am Southern Corporation), PR (Pan American Refining Corporation), SOG (Stanolind Oil & Gas Company), SPL (Service Pipe Line Company) and U (Utah Oil Refining Company).

First row—J. A. Ridgway, PR; P. E. Darling, PR; J. B. Duckworth; W. H. Hopson, SOG; J. E. Latta, SOG; J. F. Coffey; C. H. Oliver, Jr.; S. W. Walker, SOG; T. H. Rogers; R. E. Wilson, Indiana Standard chairman of board; B. K. Brown, PAS, president; H. F. Glair, Indiana, general manager, manufacturing; L. W. Moore, PR, president; J. K. Roberts, Indiana, general manager, research & development; R. N. Giles; F. J. Smith, PR; E. K. Brown; A. C. Hershey; D. L. Naef; J. A. Scobie, PR; R. F. Stahl, PR; L. Finch, Jr., SOG; T. G. Stack.

Second row—H. E. Fisher; W. L. Kennedy, SPL; A. H. Newberg, SPL; P. F. Hawley, SOG; J. E. Seebold; J. H. Rushton, Illinois Tech, consultant; W. G. Whitman, M.I.T., consultant; W. B. Littreal, U; R. A. Steel; H. M. Hart; P. R. Schultz, SOG; A. L. Conn; G. W. Schustek; R. V. Shankland; R. C. Gunness; A. S. Munneke, SPL; W. D. McEachron; M. T. Carpenter; A. W. Neeley, U; D. R. Isom, U; L. V. Durland, U; M. C. Hopkins, PR; W. H. Bahlke; R. E. Nelson, Jr.; D. G. Zink, SOG; M. C. Hoffman, PAS.

Third row—E. Field; G. M. Webb; M. D. Gjerde; D. F. Benton, Indiana, general manager of sales; B. L. Evering; E. L. Gordy; T. Redmond; H. S. Seelig; H. M. Steininger; G. R. Gray; F. S. Wood; A. P. Lien; C. H. Somans; P. J. Perille; R. R. Wilber; H. R. Snow, PR; W. B. Plummer, I president; T. A. Abbott; F. C. Roop; H. R. Taliaferro; P. C. Livesay; H. C. Brown, Purdue U., consultant; C. F. Leydig; W. J. Tancig; A. H. Fox.

Fourth row—C. M. Loane; D. S. Warning; J. E. Kline; L. B. Gordon, PR; W. L. Webb; D. A. Monro; C. G. Kustner; E. W. Thiele; R. F. Marschner; W. R. Hertwig; E. L. d'Ouville; C. W. Peters; N. Fragen; R. J. Diwoky, PAS; J. H. Forrester, SOG; M. F. Brown, Indiana manager; C. R. Harte, Jr.; R. Diekman; J. M. Stuckey, PR; R. J. Hengstebeck; F. R. Walter; B. T. Allison; J. W. Yant; R. M. Eberly.

Fifth row—D. G. Schroeter, PR; E. R. Arbegust, PR; N. E. Lemmon; P. G. Stevens; I. H. Lutz, PR; C. J. Domke; G. T. Moore; H. R. Peterson, I; R. W. Gerhard; S. C. Bean; H. G. Schnetzler; H. V. Knight; R. B. Selund; F. V. Grimm; B. H. Shoemaker; D. L. Rankin; F. A. Gitzendanner; P. H. Sullivan; J. M. Miller; R. L. Burwell, Northwestern U., consultant; R. Gottschalk; L. W. Mixon; R. H. Brown; E. B. Tucker.

Back row—G. H. Weisemann; T. B. Tom; F. T. Wadsworth, PR; W. Kaplan, PR; I. C. Staeuble; M. Gordon; J. D. Walk, PAS; A. W. Lindert; J. W. Gaynor; P. L. Brandt, PR; W. S. Peeler, PR; I. W. Farriss, PR; C. F. Feuchter, PR; W. F. Meehan; R. C. Mallatt; A. D. Watkins; S. A. Montgomery; J. G. Housman; W. H. Congleton; D. P. Barnard; M. H. Arveson, I; J. A. Back; J. W. Boatwright; W. P. Hilliker, PAS; E. W. Adams; R. B. Perkins, PR; R. H. Price, PR.

The MONTH...

but not income taxes or profit. A bureau estimate of a year ago was approximately $2.

Plant Suggestion Brings $500 to Phillips Employe

Wesley Mason, an operator supervisor at Phillips Petroleum Company's Rice gasoline plant was given a check for $500 for his suggestion that bauxite be reclaimed and used again in the isomerization unit. Previously the bauxite had been discarded after a single use. This reclamation method has been put into full-scale operation, "resulting in a substantial operating economy."

The company's suggestion committee receives about 1200 suggestions from employes each year of which approximately 30 percent is accepted.

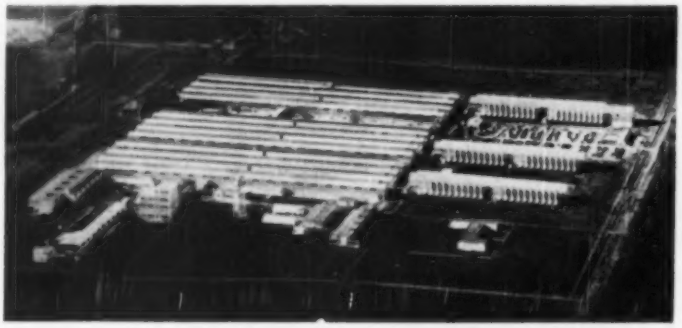
Barnsdall-Sunray Merger Becomes Effective

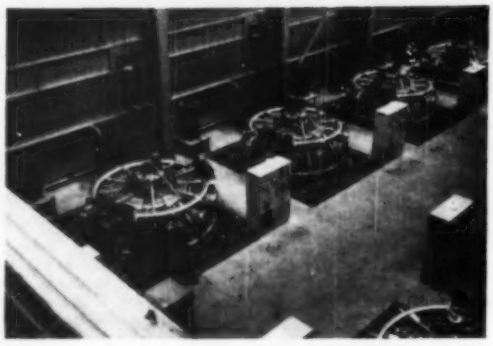
Barnsdall Oil Company and Sunray Oil Company, as a result of their recent merger, have been operating under the Sunray emblem since June 23. Sunray's activities are concentrated in Arkansas, California, Illinois, Kansas, Louisiana, Mississippi, New Mexico, Oklahoma, Pennsylvania, Texas, and Wyoming.

Board officers of Sunray are F. B. Parriott, director and chairman; C. H. Wright, director and president; Edward Howell, director, vice president and general counsel; Paul E. Taliaferro, director, vice president, and assistant to the president; D. R. Snow, director, vice president, exploration and production; F. L. Martin, director, vice president, refining and sales; W. C. Whaley, director, vice president, California division; W. D. Forster, director and secretary; Don O. Chapell, vice president, exploration manager; H. O. Harder, vice president, production manager; L. W. Bennett, treasurer; and Ben L. Young, assistant treasurer.

THE OIL MAN'S CALENDAR

1950 AUG. 14-16	Society of Automotive Engineers, West Coast Meeting, Los Angeles, Biltmore Hotel.
SEPT. 3- 8	American Chemical Society, Chicago.
5- 9	American Chemical Society, 6th National Chemical Exposition by Chicago Section, Chicago, Colliseum.
11-15	American Society of Mechanical Engineers, Industrial Instruments and Regulators Conference with the Instrument Society of America, Buffalo, N. Y., Municipal Auditorium.
13-15	National Petroleum Association, Atlantic City, N. J., Hotel Traymore.
18-22	Instrument Society of America, National Conference and Exhibit, Buffalo, N.Y., Memorial Auditorium.
25-27	American Society of Mechanical Engineers, Petroleum Mechanical Engineering Division, New Orleans, The Roosevelt.
OCT. 1- 3	Independent Petroleum Assn. of America, Annual Meeting, St. Louis, Mo.
2- 6	American Gas Association Annual Convention, Atlantic City, N.J.
16-21	Oil Progress Week.
16-20	National Safety Congress, National Safety Council Exposition, Chicago.
27	Natural Gasoline Association of America, Southern Regional Meeting, Tyler, Texas, Blackstone Hotel.
1950 OCT. 30 to Nov. 1	National Lubricating Grease Institute, Annual Meeting, Chicago, Edgewater Beach Hotel.
NOV. 2- 3	Eighth Annual Pittsburgh Conference on X-Ray and Electron Diffraction, Pittsburgh, Mellon Institute for Industrial Research.
2- 3	Society of Automotive Engineers, Diesel Engine Meeting, Chicago, Hotel Knickerbocker.
9-10	Society of Automotive Engineers, Fuels and Lubricants Meeting, Tulsa, The Mayo.
10	California Natural Gasoline Association, 25th Annual Fall Meeting, Los Angeles, Ambassador Hotel.
11-13	Oil Industry Information Committee, Los Angeles, Biltmore Hotel.
13-16	American Petroleum Institute, 30th Annual Meeting, Los Angeles, Biltmore Hotel and Ambassador Hotel.
26 to Dec. 1	American Society of Mechanical Engineers, New York, Hotel Statler.
DEC. 3- 6	American Institute of Chemical Engineers, Annual Meeting, Columbus, Ohio, Neal House.
1951 April 16-18	American Society of Lubrication Engineers, Annual Convention and Lubrication Show, Philadelphia, Bellevue-Stratford Hotel.
18-20	National Petroleum Association, Cleveland, Ohio, Hotel Cleveland.





Top, Aerial View of Alcoa's New Plant at Point Comfort, on the Texas Gulf Coast. Powerhouses are on the right and pot rooms on left. Right photo shows section of one of three engine rooms each containing 40 engines. Generators and auxiliary equipment are located on the floor below.

Alcoa Opens New Plant On Texas Gulf Coast

Aluminum Company of America has opened its new Point Comfort, Texas, Works on a 3000-acre tract near Port Lavaca, Texas, nearby natural gas fields having been the magnet that attracted Alcoa to this location. By means of generators driven by internal combustion engines, the gas is converted into electric power to make aluminum. Each of 120 Nordberg 11-cylinder, 14-inch bore, 16-inch stroke, 1600-hp. engines consumes 13,000 cubic feet of gas per hour under load. Nominal generating capacity of the power plant is 120,000 kw. and under normal operating conditions the total output of the plant will be approximately 2.75 million kilowatt hours per day.

Virtually all electrical conductors in the works is aluminum, some 5½ million pounds of aluminum bus conductor alone having been used. Aluminum wire, cable and conduit were also used extensively. In fact the covering of the production buildings at Point Comfort represents the largest single application of aluminum industrial corrugated roofing and siding to date. Brick structures include such applications of aluminum as doors, windows, lighting fixtures, and trim. The fence, and lamp poles at the works also are made of aluminum. Light metals such as aluminum are becoming more and more available for all lines of industrial construction and development.

Alcoa's new Texas plant actually replaces one that was closed some months ago at Niagara Falls, N. Y.

Another Alcoa development was last month's formal opening of a new research building at East St. Louis, Ill. A branch of Alcoa's Aluminum Research laboratories, this unit develops and improves chemical products derived from bauxite and investigates methods involved in producing them.

The MONTH...

Eleven WPRA Committees Are Named for 1950-51

R. W. McDowell, president of the Western Petroleum Refiners Association, has announced the appointment of members to the WPRA committees for 1950-51. Committees are as follows:

Executive Committee — R. W. McDowell, chairman; H. T. Ashton, Socony-Vacuum Oil Company, St. Louis; Reid Brazell, Leonard Refineries, Inc., Alma, Mich.; H. W. Camp, Cities Service Oil Company, Bartlesville, Okla.; Sheldon Clark, Sinclair Refining Company, Chicago; Harry J. Kennedy, Continental Oil Company, Ponca City, Okla.; F. L. Martin, Sunray Oil Corporation, Tulsa; Roland V. Rodman, Anderson-Prichard Oil Corporation, Oklahoma City; R. L. Tollett, Cosden Petroleum Corporation, Big Spring, Texas; and H. E. Zoller, Derby Oil Company, Wichita.

Finance Committee — H. T. Ashton, chairman; H. W. Camp; F. L. Martin; and R. W. McDowell, ex-officio member.

Membership Committee — H. T. Ashton, chairman; Reid Brazell; R. L. Tollett; and H. E. Zoller.

Legal Committee — R. H. Wills, Mid-Continent Petroleum Corporation, Tulsa, chairman; Gentry Lee, Barco Oil Company, Tulsa; and Y. A. Land, The Texas Company, Tulsa.

Manufacturing Committee — W. J. Carthaus, Deep Rock Oil Corporation, Tulsa, chairman; J. W. Vaiden, Skelly Oil Company, Tulsa, co-chairman; R. R. Irwin, Socony-Vacuum Oil Company, Kansas City; F. A. Deering, Kanotex Refining Company, Arkansas City, Kansas; Neal Prichard, Anderson-Prichard Oil Corporation, Oklahoma City; E. M. Reynolds, The Texas Company, Tulsa; H. W. Camp; R. C. Alden, Phillips Petroleum Company, Bartlesville; John S. Pfarr, Leonard Refineries, Inc., Alma, Mich.; J. B. Rogerson, Lion Oil Company, El Dorado, Ark.; W. L. Thompson, Mid-Continent Petroleum Corporation, Tulsa.

Lubricants Committee—H. W. Camp, chairman; W. F. Dowling, Continental Oil Company, Ponca City; D. R. Frey, Deep Rock Oil Corporation, Tulsa; H. J. Sheard, Bayou State Oil Corporation, Shreveport, La.; W. M. Carney, Lion Oil Company, El Dorado, Ark.; D. G. Morgan, Mid-Continent Petroleum Corporation, Tulsa.

Motor Fuels Committee—T. E. Fitzgerald, Mid-Continent Petroleum Corporation, Tulsa, chairman; Clarence Rice, El Dorado Refining Company, Elderado, Kan.; J. W. Warner, Tide Water Associated Oil Company, Tulsa; C. L. Mayhall, Anderson-Prichard Oil Corporation, Oklahoma City; H. A. Gardner, Phillips Petroleum Company, Bartlesville; L. E. Kincannon, Rock Island Refining Corporation, Indianapolis, Ind.; F. W. McCurry, Derby Oil Company, Wichita; J. W. Vaiden; H. W. Camp; W. M. Carney.

Tractor Fuel Committee — C. L. Mayhall, chairman; Jess Knowles, Skelly Oil Company, Kansas City, Mo.; E. L. Beeman, National Cooperative Refinery Assn., McPherson, Kan.; J. R. Smith, Vickers Petroleum Company; Wichita; C. W. Berger, Shallow Water Refining Company, Garden City, Kan.; F. A. Suess, Continental Oil Company, Ponca City.

Diesel Fuel Committee—C. M. Ridgway, The Pure Oil Company, Chicago, chairman; A. H. Fox, Standard Oil Company (Indiana), East Chicago, Ind.; Soma Kurtis, Aurora Gasoline Company, Detroit; E. Dunning, Shell Oil Company, New York; F. A. Suess; L. C. Beard, Jr., Socony-Vacuum Oil Company, Inc., New York; T. L. Apjohn (Alternate for Mr. Beard), Socony-Vacuum Oil Company, Inc., New York; H. D. Young, Sinclair Refining Company, East Chicago, Ind.; E. K. Anderson, Skelly Oil Company, Tulsa; T. E. DeVilliers, Cities Service Oil Company, East Chicago, Ind.; B. C. Frichot, Midland Cooperative Wholesale, Cushing, Okla.

Asphalt Committee—James J. Kelly, Kerr-McGee Oil Industries, Inc., Oklahoma City, chairman; John S. Pfarr, co-chairman; John Ward, Aurora Gasoline Company, Detroit; H. H. Below, Skelly Oil Company, Tulsa; J. K. MacKinnon, American Liberty Oil Company, Mt. Pleasant, Texas; W. G. Franke, Berry Asphalt Company, Magnolia, Ark.; A. F. Reed, Lion Oil Company, El Dorado, Ark.; H. S. Dickson, Derby Oil Company, Wichita; C. H. Dresser, Anderson-Prichard Oil Corporation, Oklahoma City.

Accounting Committee—A. R. Bell, Jr., Deep Rock Oil Corporation, Tulsa, chairman; Charles Klein, Mid-Continent Petroleum Corporation, Tulsa; Arthur W. John, Tide Water Associated Oil Company, Tulsa; Thomas F. Dowd, Jr., Continental Oil Company, Ponca

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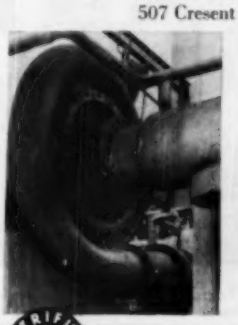

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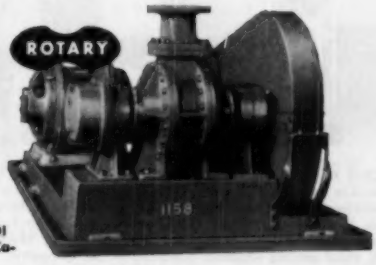
Outdoor refinery installation of Type OI Centrifugal Blower. Capacity 11,750 cfm.

R-C Cycloidal Rotary Pump for handling gas or vapor together with liquids, in petroleum processing plant.



ROOTS-CONNERSVILLE

BLOWER BUILDERS SINCE 1854

ONE OF THE DRESSER INDUSTRIES

The MONTH...

City; Virgil Marshall, Skelly Oil Company, Tulsa; Roy Parr, Phillips Petroleum Company, Bartlesville.

Morrison-Knudsen Firm Takes Over H. K. Ferguson

Morrison-Knudsen Company, Inc., construction firm, has purchased H. K. Ferguson Company for a sum of more than $7 million. Engineering and building operations of the Ferguson firm will not be affected by the sale. Otto F. Sieder will continue as executive vice president of the Ferguson firm, which has home offices in Cleveland, Ohio, and New York. John and Stirton Oman of Oman Construction Company of Nashville, Tenn., formerly owned the concern.

New Officers Selected For NGAA Corrosion Task

T. S. Zajac, corrosion engineer, Shell Oil Company, Houston, has been elected chairman of the Natural Gasoline Association of America's corrosion research project committee. He succeeds W. H. Stewart, Sun Oil Company, Beaumont, Texas, who has been chairman for the past two years. F. A. Prange, chief metallurgist, Phillips Petroleum Company, Bartlesville, Okla., was elected vice chairman of the committee.

These men together with T. S. Bacon, Lone Star Producing Company, Dallas; H. E. Waldrip, Gulf Oil Corporation, Houston, and P. P. Spafford, Stanolind Oil & Gas Company, will comprise the Steering Committee which will direct the activities of the committee in its seventh year of operation. A cooperative program under the sponsorship of the NGAA, the project has been given the financial support of 29 different oil companies and more than $100,000 has been spent in fundamental and practical research.

Dr. Norman Hackerman and Dr. H. L. Lochte, University of Texas, have been directing two research programs at the university and most of this work is to be continued.

Cities Service Director Gets Armour Research Post

Dr. Rolston L. Bond, technical director of the butadiene division of Cities Service Refining Corporation, Lake Charles, La., has been named assistant chairman of the chemistry and chemical engineering department at Armour Research Foundation of Illinois Institute of Technology. Bond will be in charge of the foundation's biochemistry and organic chemistry research activities.

With Cities Service since 1943, Bond was a research chemist for Tidewater Associated Oil Company and National Oil Products Company from 1938 to 1943.

ECA Grants Dollar Aid To Societa Permolio

Societa Permolio is expected to be able to increase output of light products at the expense of fuel oil as a result of an ECA agreement to underwrite installation of new cracking units at SIP's Rome and Genoa refineries. Also, ECA agreed that part of the $1.5 million it will put up, can be used by Italians for a lube oil unit at their Milan refinery. Total cost of the three projects is estimated by ECA as approximately $5 million.

PROCESS HEATING SEMINAR—The John Zink Company's first annual process heating seminar was held in Tulsa June 10 and drew considerable attendance from engineering and operating groups of Southwestern refineries and chemical plants. The technical program presented included several papers. "Metallurgy for High Temperature—High Sulfur Process Conditions," was given by Francis Fahrenwald, Fahralloy Corporation; "Performance of Thermal Poly Trans-Economizers," by J. H. Smith, chief process engineer, Continental Oil Company; "Economics of Waste Heat Recovery," by L. D. Stewart, process engineer, Mid-Continent Petroleum Corporation; and "A New Approach to Design for Radiant Heat Transfer in Process Work," by Robert Reed, chief engineer, John Zink Company. Also a part of the program was a "Question and Answer Session" in which experts from engineering and operating companies answered questions on process design and plant operations. The panel of experts, shown left to right in photo, included Harold Bottomley, Refinery Engineering Company; J. L. Parker, Girdler Corporation; Sidney Born, Born Engineering Company; Davis Read, Universal Oil Products Company; D. F. Gerstenberger, Alcorn Combustion Company; T. B. Leech, Petro-Chem Development Company; L. B. Sutherland, C. F. Braun Company; and Duane Fuqua, Koch Engineering Company. Robert Reed, chief engineer, John Zink Company, who conducted the sessions, is behind the column at the right.

Texaco Develops Knockless Fuel Combustion Process

A new engine which employs a radical change in combustion technique—a change which eliminates "knock" and points to a 30 percent increase in miles per gallon—was described last month by Texaco engineers to the Society of Automotive Engineers. The new combustion process is still being tested in a single-cylinder engine. A multi-cylinder engine will not be built for road testing before the middle of 1951.

The basic concept of the new process is "to make the residence time of combustible mixture (in combustion chamber) so brief, that spontaneous ignition and knock will not occur." This is accomplished by introducing the air-fuel mixture into a continuous air swirl in the combustion chamber and burning the mixture almost instantly. The mixture is carried by the miniature whirlwind a short distance to the spark plug where it ignites.

Features claimed for the process include: a) compression ratio that may be increased without regard for the octane number of the fuel; b) employment of supercharge in combination with high compression ratio, without regard for the octane number of the fuel; c) an ability to burn lean mixtures, resulting in part-load fuel economy in most any engine application; d) control of load mixture by strength, without air throttling; e) and engine's utilization of fuels having no octane or cetane number specification and a broad boiling range.

Du Pont Names Manager For Gulf Coast Group

Alfred R. Mullis has been appointed manager of the Gulf Coast district office of the petroleum chemicals division of E. I. du Pont de Nemours and Company, Inc., with headquarters in Houston. The division manufacturers and markets tetraethyle lead antiknock compounds for gasoline and chemicals for the petroleum and gasoline refining industries.

Mullis has been with Du Pont since 1947 as a petroleum chemicals division service representative in the Gulf Coast district. Before, he was employed in the research and development department of Humble Oil & Refining Company, Baytown, Texas. He is a chemical engineering graduate of Rice Institute.

Companies Rebuke Charges In West Coast Oil Suit

Standard Oil Company of California considers the antitrust suit filed against it and six other west coast oil majors "to be the gravest injustice ever lodged against the oil industry." Among the many charges in the government's complaint is that the seven companies have conspired to monopolize production. The suit demands that the companies be separate from the retail outlets they own or which have contracts for sale of any one of the companies' products.

The seven companies, along with the Conservative Committee of California Oil Producers, are also accused of conspiring to destroy all other western companies in every branch of the oil business to monopolize the entire petroleum industry in the Pacific west.

Charles S. Jones, president of Richfield Oil Corporation, said that confu-

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Today, thanks to the fluid cracking techniques used in modern refining operations, it is possible to produce high octane fuels to match the requirements of engines of high compression ratio. Contributing vitally to this progress has been Cyanamid's development of AEROCAT* Ground and Microspheroidal Synthetic Fluid Cracking Catalysts.

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Other Cyanamid specialties for the Petroleum Industry include AEROLUBE* Additives for regular, premium and heavy-duty motor oils . . . AERO** Specialty Catalysts for various chemical processes . . . Gasoline Dyes and Drilling Mud Chemicals. Literature and samples of these products are available on request. Write today.

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The MONTH...

sion and chaos, and higher oil products prices, would result from successful prosecution by government of this suit. Such a situation, he said, probably would lead to a demand for nationalization of the oil industry and the inevitable destruction of the majority of 30,000-odd dealers in petroleum products in the West.

Businessmen were urged by President Robert L. Minckler of General Petroleum Corporation to support the campaign against the charges. Minckler asserted that the antitrust suit was an outgrowth of confusion of law.

Besides Standard, Richfield and General, other company defendants are The Texas Company, Shell Oil Company, Tide Water Associated Oil Company, and Union Oil Company of California.

Trends of Operations and Changes in Stocks

Figures on crude stocks are from Bureau of Mines weekly reports; all others from American Petroleum Institute weekly reports, which are estimates on Bureau of Mines basis.

(All figures in thousands of barrels—add 000)

Trends in Week Ended	Crude Oil			Gasoline		Gasoil and Distillate		Residual Fuel	
	Production Daily	Runs to Stills Daily	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End
1949:									
January 29	5,493	5,490	255,450	17,531	114,677	7,547	63,142	8,178	63,333
February 26	5,401	5,412	261,965	17,621	124,382	7,430	54,008	8,225	59,348
March 26	5,188	5,353	266,506	17,417	128,087	6,167	48,721	8,305	58,792
April 30	4,980	5,273	271,255	17,969	124,787	6,681	49,959	8,185	60,174
May 28	4,951	5,297	275,190	18,324	120,661	5,943	55,971	8,144	63,758
June 25	4,944	5,322	274,114	18,462	115,715	5,148	63,049	7,856	66,146
July 30	4,731	5,187	271,999	18,056	108,964	6,293	70,767	7,205	67,166
August 27	4,769	5,215	266,455	18,180	105,280	6,491	74,718	7,597	68,394
September 24	4,933	5,377	259,189	18,152	103,262	6,555	81,414	7,419	68,143
October 29	5,075	5,509	252,069	19,002	103,915	7,016	90,358	7,754	69,459
November 26	5,192	5,331	256,409	18,204	104,917	6,971	91,795	8,104	67,087
December 24	4,955	5,482	256,830	18,045	110,164	7,335	78,652	8,046	61,647
1950:									
January 28	4,956	5,470	248,411	18,363	124,270	7,302	66,337	8,389	57,036
February 25	5,000	5,277	245,566	17,703	133,888	6,890	56,050	7,855	48,663
March 25	4,848	5,469	244,227	17,839	135,406	6,870	40,577	8,171	42,546
April 29	5,014	5,314	244,744	18,038	128,655	6,531	36,686	7,272	39,260
May 27	5,118	5,591	240,842	18,704	122,757	7,201	40,607	7,421	39,308
June 24	5,355	5,636	240,762	19,626	115,036	6,868	50,580	7,461	41,291

Stanolind Formally Opens North Cowden Gaso Plant

The North Cowden plant operated by Stanolind Oil and Gas Company and with a design capacity of 50 million cubic feet of gas was formally opened July 1. Its present capacity recovers 150,000 gallons of liquid products daily including 35,000 gallons propane, 23,000 butane, and 93,000 of 26-pound Rvp. natural gasoline. Most of the process area was designed with views of an eventual capacity of 100,000 mcf. Construction was by Stearns-Roger Manufacturing Company, Denver.

Portions of the residue or dry gas are injected back into the producing formation, and others are used for plant, camp, and lease fuel with the remainder being sold to a nearby carbon-black plant.

Owners include The Texas Company, Cities Service Oil Company, Sinclair Oil and Gas Company, Sun Oil Company, The Atlantic Refining Company, Tide Water Associated Oil Company, Continental Oil Company, Aline C. Delaney, Mid-Continent Petroleum Corporation, Amerada Petroleum Corporation, D. E. Kervin, William E. McBee, The Ohio Oil Company, Kiska Oil Company, Texas Gulf Producing Company, Edward E. Reigle (trustee), Acme Oil and Royalty Company, Iva C. Richmond, Ocie Virginia McDonald, Janice Florine Whitted, and Stanolind Oil and Gas Company.

Holton New CIA Head

George V. Holton, chairman of the board, Socony-Vacuum Oil Company, Inc., has been elected president of the Commerce and Industry Association of New York, Inc., for the 1949-50 fiscal year. Holton, a member of the board of directors, had been vice president of the association since 1948. He succeeds Walter Hoving, president of Hoving Corporation, who served two terms as association president.

Holton, formerly general counsel of Socony-Vacuum, is director, member of the executive committee and vice president.

NPA Officers Named

H. C. Salisbury, Kendall Refining Company, Bradford, Pa., has been elected president of the National Petroleum Association, fire and accident prevention department, at the 25th anniversary meeting, Cleveland, Ohio. Other officers are Russell J. Potts, Indiana Farm Bureau Refinery, Mt. Vernon, Ind., first vice president; F. A. Nicholson, Elk Refining Company, Charleston, W. Va., second vice president; W. E. Dunning, Freedom-Valvoline Oil Company, Freedom, Pa., treasurer; and H. C. McConnell, The Pure Oil Company, Toledo, Ohio, secretary.

Phillips Develops Rubber Made Without Styrene

A new synthetic rubber, made without styrene, and said to be superior to GR-S synthetic rubber and perhaps to natural rubber for tire treads, has been developed by Phillips Petroleum Company in cooperation with the Office of Rubber Reserve.

The new rubber, called polybutadiene or "PB" rubber, is made from butadiene. It was obtained in Phillips labs by making it much softer than usual with a modified recipe and at moderately low temperatures. In the new process, high abrasion furnace carbon black is mixed with the polybutadiene latex before conversion to solid rubber.

NRAA Names Counsel

The Independent Refiners Association of America has appointed Norman L. Meyers as its national counsel. Meyers, a graduate of Yale Law School and Brookings Institution, was a former member and executive secretary of the Petroleum Administrative Board and was the first chairman of the Federal Tender Board when it succeeded in stopping "Hot Oil." He was also counsel for the OPA Petroleum Refining Industry Advisory Committee. In his private law practice Meyers has engaged in administrative practice and anti-trust law for oil and other major industries.

Du Pont Names Director

Dr. John M. Herndon, assistant manager of Chambers Works, Deepwater, N. J., has been named director of manufacture of E. I. du Pont de Nemours and Company, Inc.'s organic chemicals department. He succeeds Dr. Samuel Lenher, who will become the department's new assistant general manager. Dr. Lenher was appointed to succeed Dr. William Kirk, retiring.

Kellex Is Sold by Kellogg

The M. W. Kellogg Company last month sold the stock and assets of one of its subsidiaries, The Kellex Corporation, to The Vitro Manufacturing Co.

"This step," Kellogg President Warren L. Smith said, "is in accord with Kellogg's policy of concentrating its commercial development, engineering and manufacturing efforts in the petroleum, chemical and power fields and of confining its governmental contracts to development engineering and manufacturing in the fields of jet propulsion, guided missiles, etc." These latter activities are conducted by Kellogg's special projects division in Jersey City.

Contracts currently held by Kellex, primarily in the field of atomic energy development, will be continued by that organization.

Petrol Refining Names Head

V. A. Fogg, representing the G. L. F. Exchange, Inc., a co-op, was last month elected president of Petrol Refining, Inc. Fogg has been acting president of the refining company since April 1, succeeding Eugene Callis, who organized the company as a co-op in 1948.

Socony Manager Retires

C. C. Benedict, eastern regional operating manager of Socony-Vacuum Oil Company, Inc., has retired, to be succeeded by M. M. Beckes, operating manager of the lubrite division, St. Louis, Mo. Beckes' headquarters will be in New York.

Petreco Moves Offices

Petroleum Rectifying Company of California has moved offices to 1390 East Burnett Street, Long Beach 6, Calif. The company is a division of Petrolite Corporation, Ltd.

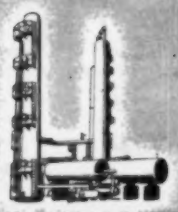
Panoma Has New Offices

Panoma Corporation, formerly located in the Amarillo Building, Amarillo, Texas, has moved offices to 701 First National Bank Building.

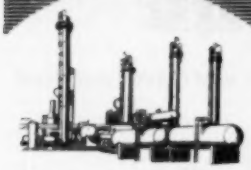
Houdry Chem Engineer Dies

Edward F. Everett, chemical engineer with Houdry Process Corporation, Philadelphia, died suddenly May 24. He was 35 years old.

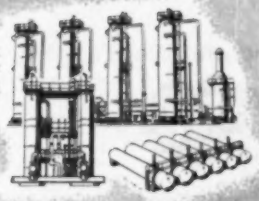
POWER DIVISION



CHEMICAL DIVISION



PETROLEUM DIVISION



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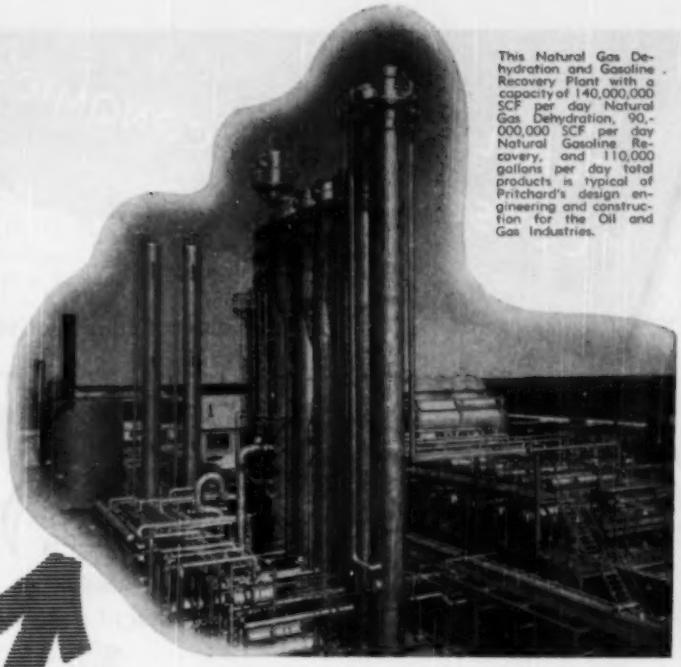

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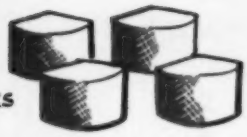
Easy Lesson in CONSERVATION ECONOMICS

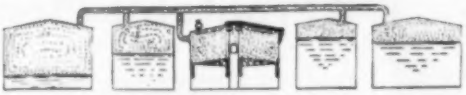
If you have several cone roof tanks 

that can be interconnected,

you can convert breathing losses and filling losses

into profits quickly. Field studies at a typical gasoline plant

show $aving$ of more than 5,000 gallons a week when six cone roof

tanks were hooked up  with a

Wiggins DRY SEAL Gasholder. Including expenses,

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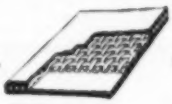
the Wiggins 100% DRY SEAL  cuts out rain

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SCIENCE and TECHNOLOGY Abstracts

Prepared by
DR. E. H. LESLIE and DR. H. B. COATS
The Leslie Laboratories
Traver Road, Ann Arbor, Mich.

Manufacture: Processes and Plant

Heat Transfer in Stable Film Boiling. LEROY A. BROMLEY. *Chem. Eng. Progress*, **46** (1950), pp. 221-7.

The term, film boiling, applies to that type of boiling that occurs when a complete vapor film exists between the heated surface and the boiling liquid. Equations are presented, derived from a few simple premises and well verified by extensive experimental data, to make possible the calculation of the coefficients of heat transfer to be expected in natural convection stable film boiling from a horizontal tube. The method can be applied to derive equations for heat-transfer coefficients to be expected in film boiling from any other shape of surface. Equations are derived for the case of film boiling from a vertical tube or from a vertical plane surface. The rate of heat transfer or coefficient in film boiling is low and of the order of magnitude of 15 to 80 Btu. per (hr.) (sq. ft.) (°F.). This compares with coefficients as high as 10,000 Btu. per (hr.) (sq. ft.) (°F.) in nucleate boiling, or the type of boiling most commonly encountered. A bibliography of 25 references is included.

Calculation of Minimum Reflux in Distillation Columns. R. N. SHIRAS, D. N. HANSON, AND C. H. GIBSON. *Ind. Eng. Chem.*, **42** (1950), pp. 871-6.

The calculation of minimum reflux is important as an initial step in the design of distillation columns and as a correlating property in research on distillation calculations. The authors briefly review the methods that have been proposed and used. The article in concerned with three methods for calculating minimum reflux rates in distillation columns handling multicomponent solutions. The first method is based on some overlooked equations published originally in 1932. It is simple, but is rigorous only for a restricted class of separations. The second procedure is an extension and elaboration of a method published by Underwood. This so-called "ϕ function" method is rapid and exact for all separations for which the assumption of constant overflow and constant volatility rates are valid. It is also an approximate method for all column design problems as normally encountered. The third method is an adaptation of the Thiele and Geddes plate-by-plate method of calculating finite plate columns. It is completely general, since variable overflow and variable volatility ratios can be taken into account, and there is no restriction as to the type of separation. The authors recommend it as a tool for use in distillation research, but regard it as too laborious for plant design work. A bibliography of 13 references is included.

Batch Rectification. JU CHIN CHU. *Chem. Eng. Progress*, **46** (1950), pp. 215-20.

The author applies Smoker's equation and Eshaya's method to derive analytical expressions for binary solutions to give the yield of distillate of a given composition obtainable by batch fractionation of a given charge in an ideal column or in a column with holdup. The reflux ratio is continuously increased throughout the rectification process in order to maintain constant product composition with finite reflux ratio at the cutting point. Equations are applicable to complex mixtures if the effective binary system as proposed by Hengstebeck is employed. A bibliography of 13 references is included.

Purification by Fractional Melting. J. G. ASTON AND S. V. R. MASTRANGELO. *Analytical Chem.* **22** (1950), pp. 636-9.

Although crystallization is one of the oldest methods of separation, the possibility of using solid-liquid equilibria in a manner analogous to vapor-liquid equilibria for efficient separation has not been widely recognized. The separation of a single pure solid from a liquid of two components is similar to the removal of the vapor of a substance from a liquid solution with a nonvolatile substance. The paper describes the work on a single-step separation of a purer substance as a solid from a liquid mixture in equilibrium with it, usually where no solid solution was formed, and by fractional melting. The advantages over fractional distillation are poined out. As a typical example showing the efficiency of the process, the progress of purification of a 500 ml. sample is given. The separation of cis-2-butene from trans-2-butene is described. By combining the method with rough fractional distillation of the eutectic mixture, the procedure should, in most cases, prove superior to precise fractionation.

These abstracts are selected from the current literature of science and technology, not including trade journals easily available. Photostatic copies of original articles will be supplied at cost by The Leslie Laboratories. Complete or limited bibliographies covering special topics by title, by abstracts, or in complete manuscript, also will be prepared and furnished by arrangement with the Laboratories.

Continuous Viscosity Control. W. M. TRIGG. *Chem. Eng.*, **57** (1950), pp. 156-7.

Satisfactory and reliable instruments for the continuous measurement and control of many process variables have been available for many yaers, but the continuous measurement of viscosity is a comparatively recent development. The instrument described was designed to measure pressure drop as a dependent variable which is a function of fluid viscosity. A schematic diagram is presented that illustrates the simple mechanical principle of the continuous viscosimeter. Liquid is supplied at constant volume from a rotary pump to the metering tube. Pressure taps on each end of the metering tube are connected to a pneumatic bellows-type differential pressure transmitter that converts the liquid differential pressure to an amplified air pressure at a constant amplification ratio. The air pressure varies linearly with viscosity. A bourdon pressure gage calibrated in viscosity units and placed in the output line serves as a viscosity indicator. The application of the instrument to control is then described. The instrument has been used for a number of years to control wire enamel in the 20 cp., 100° F. range. It has also been used to indicate and control viscosity in the bodying of drying oils, and for similar purposes. By the use of two instruments in series operating at different temperatures, the viscosity index of a liquid can be continuously measured or controlled.

Continuous Flow Stirred Tank Reactor Systems. DONALD R. MASON AND EDGAR L. PIRET. *Ind. Eng. Chem.*, **42** (1950), pp. 817-25.

The authors review the method for designing systems in which a solution flows through a row of reaction compartments and when steady-state conditions obtain. In starting and stopping such systems transient conditions arise. To handle the mathematics involved, the Laplace transform method of solving linear constant coefficient differential difference equation is used to solve in a relatively simple manner the rate equation of the system for a wide variety and number of conditions. The expressions developed completely describe the changes that occur in continuous stirred tank reactor systems during transient periods of operation. The reactant and product concentrations are given as functions of time when single, simul-

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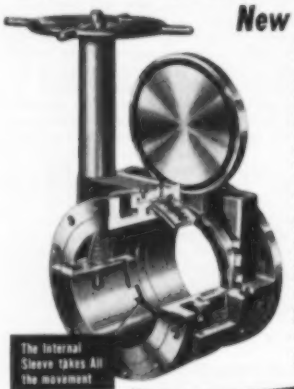

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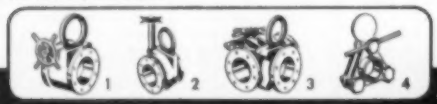

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taneous, consecutive, or reversible first-order reactions occur in the system, or when a nonreacting system is being purged of its contents. The expressions are applicable when the system is changing from one steady-state operating condition to another, and under some circumstances when the system is being started or shut down. The mathematical solutions are given for systems of vessels all having the same volumes, all having different volumes, and combinations of these systems. The method has advantages over the more specific mathematical methods that have been used previously in this field, and the authors feel that it should find applications in other branches of chemical engineering.

Turbulent Diffusion in Fixed Beds of Packed Solids. Robert A. Bernard and Richard H. Wilhelm. *Chem. Eng. Progress*, **46** (1950), pp. 233-44.

The investigation was concerned with turbulent diffusion in beds of packed solids through which a fluid is flowing. The practical application of the work lies in the design of catalytic reactors and in packed-tube heaters, coolers, mixers and absorbers. Experiments were made with a liquid phase using methylene blue solution diffusing from a point source into water flowing through a bed of packed solids. Gas phase experiments were made with carbon dioxide diffusing into an air stream in a bed of solids. The basic differential equation was solved for the special case of the tube wall as a boundary condition. A 2-inch tube was used in the aqueous experiments with various types and shapes of solids within the tube. Gaseous experiments were performed in an 8-inch tube using ¾-inch spheres for filling. The experimental range covered modified Reynolds number from 5 to 2400. Pressure-drop data were taken and correlated. A lower Reynolds limit for the stability of turbulent diffusion caused by gross wall-generated eddies was observed and the phenomena are discussed in the article. Data are presented in detail in tabular and graphical form and a bibliography of 11 references is included.

Hydrogenation of Coal in a Fluidized Bed. E. L. Clark, M. G. Pelipetz, H. H. Storch, Sol Weller, and Stanley Schreiber. *Ind. Eng. Chem.*, **42** (1959), pp. 861-5.

The authors suggest the desirability of developing a dry-coal hydrogenation process. Several features of the Bergius-I. G. process are undesirable, as, for example, the difficult handling of a residue-oil slurry, reaction space required for the recycling oil, and the deleterious effect of recycle oil on the hydrogenation of coal. Laboratory-scale hydrogenation tests of a Wyoming bituminous coal in an agitated or fluidized bed of solids produced oil yields of 20 to 27 percent and hydrocarbon gas yields of 20 to 27 percent of moisture- and ash-free coal. These results were obtained at hydrogen pressures of 1000 psi. and less. Thus the hydrogenation of a fluidized coal bed offers a possible means of dry coal processing at pressures well below those used in the European plants. In addition to oil and hydrocarbon gases, the residual product is a char suitable

for use as fuel or as fed for gas production.

Conversion in Thermofor Catalytic Cracking. R. A. McKean and L. F. Grandey. *Chem. Eng. Progress*, **46** (1950), pp. 245-8.

The operator of a petroleum catalytic cracking plant desires maximum gasoline production. The investigation reported was concerned with the effect of changing process conditions on gasoline production. In Thermofor catalytic cracking the process variables are oil-residence time, catalyst-to-oil ratio, reaction temperature, catalyst activity and feed-stock characteristics. The paper presents an improved correlation of feed-stock conversion with space velocity and catalyst-to-oil ratio. The correlation is based upon an empirical formula which has been tested with pilot plant and commercial data.

Fundamental Physical and Chemical Data

The Vapor Pressure, Orthobaric Liquid Density, and Critical Constants of 1-Butene. James A. Beattie and Stanley Marple, Jr. *Jour. Am. Chem. Soc.*, **72** (1950), pp. 1449-52.

The vapor pressure and orthobaric liquid density of 1-butene were measured in the range 30-125° C. Pressures are represented fairly well by an equation that is given. The data of the authors and those of Lamb and Roper are represented well by an equation which is presented. The measured critical constants of 1-butene are $t_c = 146.4 \pm 0.3$° C. $P_c = 39.7 \pm 0.3$ normal atm., $v_c = 0.241$ liter per mole (4.30 ml. per g.), $d_c = 4.15$ moles per liter. The uncertainty is 5 percent in the critical volume and in the density.

Vapor Pressures and Rates of Evaporation of Straight-chain Paraffin Hydrocarbons. R. S. Bradley and A. D. Shellars. *Proc. Roy. Soc.*, (London) **A198** (1949), pp. 239-51.

The vapor pressures, latent heats of vaporization and fusion, and diffusion coefficients of the vapors in air were determined at 15 to 40° C. for n-$C_{18}H_{38}$, n-$C_{19}H_{40}$, and n-$C_{20}H_{42}$. The rates of evaporation of drops and solid beads agree with previously published theory, and give a value of unity for the evaporation coefficient. A new experimental procedure is described for determining the self-cooling of a drop upon evaporation. The preparation and the physical properties of the hydrocarbons are given. The meaning of the results in relation to the size and shape of the hydrocarbon molecules is discussed. The radii of the hydrocarbon molecules studied are deduced. The authors indicate that the results can best be understood on the basis of the hypothesis of a helical molecule.

Adjustment of Temperature Scale of Cox Charts. C. E. Rehberg. *Ind. Eng. Chem.*, **42** (1950), pp. 829-30.

As generally used, the Cox chart presents a graphical representation of the

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Antoine equation,

$$\log P_m = A - B/(t - C)$$

in which A, B, and C are constants. In most work, not of the highest precision, C is taken as 230, which is an average value. A simple method of determining the proper value of C is needed. The author found that the value of C can be adjusted to any chosen value by adding or subtracting the appropriate number for each temperature on the calibrated scale. Thus any one type of ruled Cox chart paper can easily be adapted to give straight lines for the temperature-vapor pressure relationship for any type of compound.

Viscosity of Highly Compressed Fluids. L. Grunberg and A. H. Nissan. *Ind. Eng. Chem.*, **42** (1950), pp. 885-91.

The experimental determination of the viscosity of highly compressed gases and of liquids near the critical point is difficult to determine and few results have been published. The correlations of available published data are reviewed, but it is noted that the charts suffer from the same defect, namely, that in the critical region they are both inaccurate and difficult to interpolate. This disadvantage derives from the fact that pressure was chosen as one of the parameters. If density instead of pressure is used as the second parameter, the difficulty will not arise. The authors, accordingly, correlate viscosity with critical constants in such manner that the viscosity is given as a function of the reduced temperature and reduced density. The accuracy obtainable is of the order of ±10 percent. The equation given is such that the result is a function independent of the nature of the substance and dependent only on reduced density.

Hydrocarbon Azeotropes with Acetonitrile. Richard B. Bishop and William I. Denton. *Ind. Eng. Chem.*, **42** (1950), pp. 883-5.

Acetonitrile has recently become commercially available and interest has therefore been stimulated in the possibility of using this substance as a selective separating agent. The literature covering the use of acetonitrile for separation of hydrocarbons is briefly reviewed. The investigation on which a report is made was conducted to determine the behavior of acetonitrile with hydrocarbons of different types, the boiling points of azeotropes, and the compositions of the azeotropes. Fifteen hydrocarbons representative of aromatics, n-olefins, paraffins, and naphthenes were distilled with acetonitrile. As a result of the work it was concluded that benzene and toluene are the only aromatic hydrocarbons that form azeotropes; that paraffins, n-olefins, and naphthenes containing up to nine carbon atoms form azeotropes; and that the boiling points and compositions of the nonaromatic hydrocarbon azeotropes can be approximated by using the laws of distillation of immiscible liquids. The data are presented in tabular and graphical form and a bibliography of 11 references is included.

Chemical Composition and Reactions

Hydrogen Transfer. IV. Reaction of p-Isobutyltoluene and of p-s-Butyltoluene with Methylcyclohexene. Herman Pines, D. R. Strehlau and V. N. Ipatieff. *Jour Am. Chem. Soc.*, **72** (1950), pp. 1563-8.

The reaction of 4-methylcyclohexene with p-isobutyltoluene or p-s-butyltolune in the presence of hydrogen fluoride or of sulfuric acid yielded products resulting from a hydrogen transfer in which the aromatic hydrocarbon acted as donor and 4-methylcyclohexene as acceptor. The compounds formed are described.

The Thermal Decomposition of Pentane. R. G. Partington, F. J. Stubbs, and Cyril N. Hinshelwood. *J. Chem. Soc.*, (1949), pp. 2574-9.

The decomposition of pentane was studied at 530° C. and at pressures up to 500 mm. The probability of initial rupture of the chain between the second and the third C atoms is approximately twice that of one between the first and second C atoms. When rupture occurs between the second and third C atoms, ethane and propylene are more frequently formed than ethylene and propane. The composition of the gaseous products obtained is given. The energy of reaction of the molecular rearrangement over a temperature range of 508-580° C. is approximately 76 kcal./g. mol.

The Low Temperature, Low Pressure, Hydrogen Atom Initiated Combustion Hydrocarbons. Elmer J. Badin. *Jour. Am. Chem. Soc.*, **72** (1950), pp. 1550-3.

The combustion of isobutane was initiated by atomic hydrogen at 20° C. and 0.20-0.55 mm. pressure. It was found that peroxides were formed under these conditions by a wall reaction. The primary oxidation products were acetone and formaldehyde in approximately 1:1 ratio. The nature of the surface strongly affects oxidation; water and phosphoric acid increase the rate of combustion. A comparison of the relative rates of oxidation and the products from methane, propane, propylene, n-butane, isobutane, 1-butene and 2-butene was made. As a result of examination of infrared spectra it was thought that the organic peroxide present in the products contains the hydroperoxide group.

The Kinetics of the Thermal Decomposition of Normal Paraffin Hydrocarbons. II. Comparative Measurements on the Series from Propane to n-Decane. F. J. Stubbs, and Sir Cyril Hinshelwood. *Proc. Roy. Soc.*, **201** Series A No. 1064 (1950), pp. 18-26.

The normal reaction by which paraffins decompose includes radical chain reactions and molecular rearrangement. The molecular rearrangement increases in importance with the ascent of the series, and for a given hydrocarbon, with increasing pressure. For each hydrocarbon, the order of reaction varies between the first and second. There is no uniform transition from second order to first order for unimolecular reactions dependent on a single mode of activation by collision. Some reaction processes remain of second order up to high pressure. The decomposition rate for a given hydrocarbon pressure reaches a limit as the series is ascended.

The Oxidation of Butene-1 Induced by Aluminum Borohydride. Richard S. Brokaw, Elmer J. Badin, and Robert N. Pease. *Jour. Am. Chem. Soc.*, **72** (1950), pp. 1793-5.

The paper is one in a series dealing with the induced combustion of hydrocarbons, in this instance by the use of aluminum borohydrides. Most of the data referred to the combustion of butene-1, but some observations on n-butane, propane and butadiene-1,3 are given. Using aluminum borohydride in dry oxygen, n-butane gave no explosion, butene-1 exploded after an induction period, and butadiene-1,3 yielded immediate explosion. Combustion products from butene-1 were studied. The limits and effects of total pressure were determined. There is evidence of the initial reaction between butene and borohydride as the starting mechanism of the reaction.

Reaction of Thiophene with Olefinic Compounds. Herman Pines, Bruno Kvetinskas and J. A. Vesely. *Jour. Am. Chem. Soc.*, **72** (1950), pp. 1568-71.

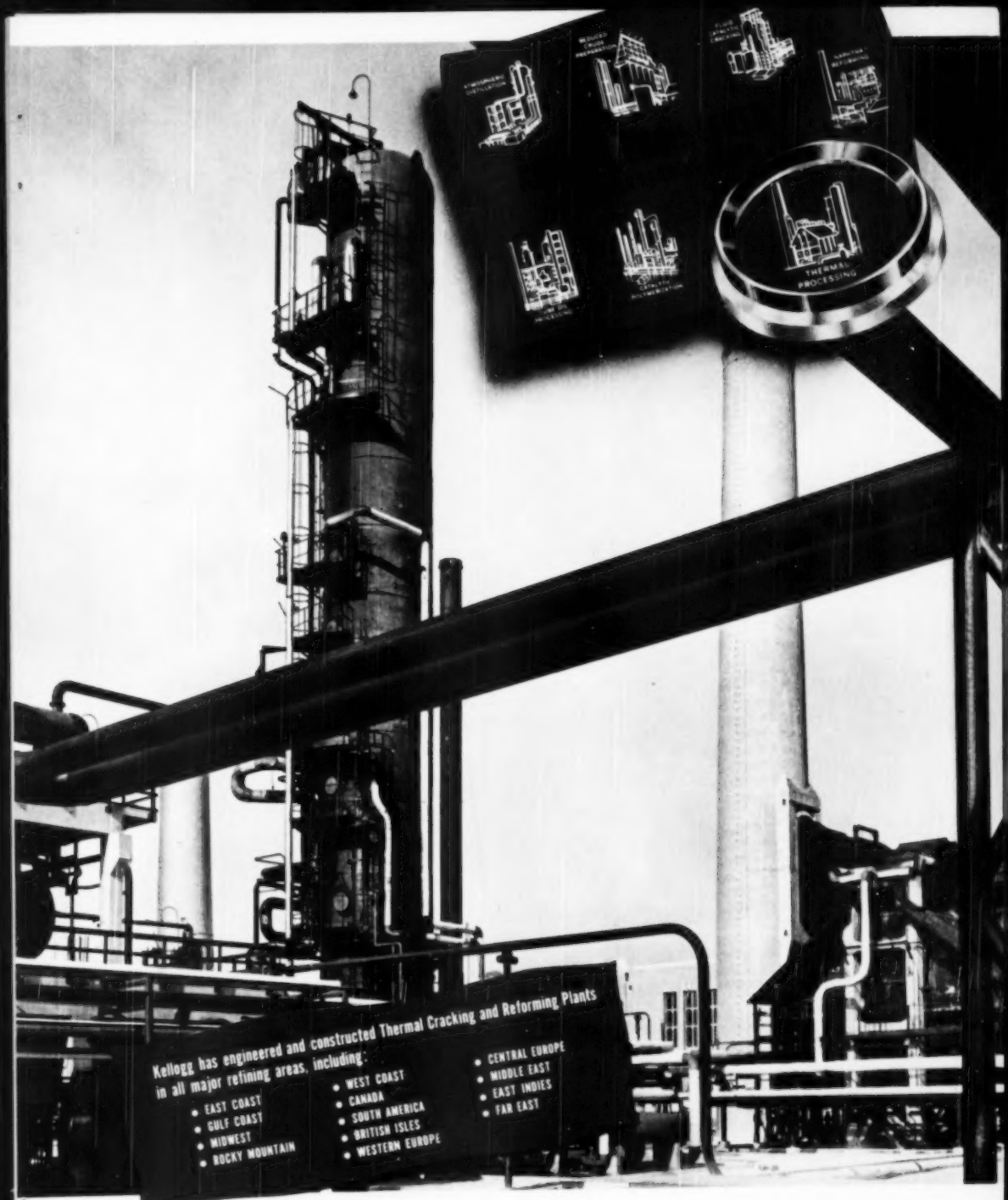
The investigators found that propene, 2-butene, 1-octene, cyclohexene, bicycloheptene, cyclopropane, α-methylstyrene, and methallyl chloride reacted with thiophene in the presence of boron fluoride-ethyl ether complex. Stannic chloride catalyzed the alkylation of thiophene with olefinic hydrocarbons only when the double bond was attached to a completely substituted carbon atom. In the case of the olefinic hydrocarbons such as propene, 2-butene, isopropylethylene, cyclohexene or 4-methylcyclohexene, the alkylation did not occur unles nitromethane was added. Phosphoric acid, a mixture of phosphoric and sulfuric acids and ethanesulfonic acid were studied as catalysts for the alkylation of thiophene. The substance of 2-Bromothiophene was alkylated.

Desulfurization of Heptane Solutions of Organic Sulfur Compounds. J. R. Meadow and T. A. White. *Ind. Eng. Chem.*, **42** (1950), pp. 925-9.

In order to study the effect of a desulfurizing agent on a particular organic sulfur compound, solutions of the sulfur compounds were made in n-heptane as an inert hydrocarbon diluent. Data are presented to show the desulfurizing action at room temperature, of 95 percent sulfuric acid, concentrated sulfuric acid saturated with nitrogen dioxide, anhydrous aluminum chloride and bromide, anhydrous hydrogen fluoride, and aqueous solutions of hydrogen fluoride on various organic sulfur compounds. Of the reagents used, concentrated sulfuric acid, nitrogen dioxide in 95 percent sulfuric acid, and anhydrous hydrogen fluoride were the most effective desulfurizing agents studied. Hydrogen fluoride has certain economic advantages in recovery and re-use. The sulfuric acid-nitrogen dioxide mixture was effective in removing alkyl disulfides which were relatively unaffected by the other desulfurizing agents.

Chemical Characterization of Catalysts. I. Poisoning of Cracking Catalysts by Nitrogen Compounds and Potassium Ion. G. A. Mills, E. R. Boedecker, and A. G. Oblad. *Jour. Am. Chem. Soc.*, **72** (1950), pp. 1554-60.

The authors note that little real in-



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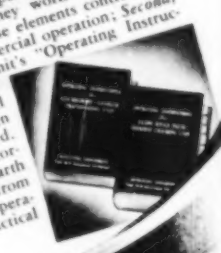

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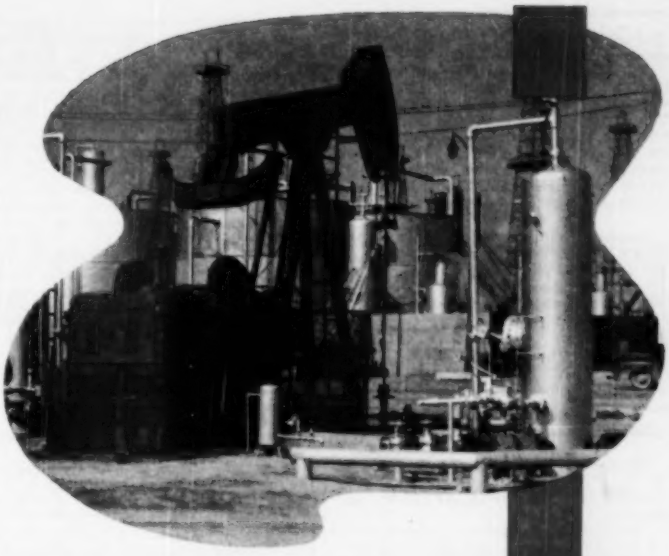
sight into the action of catalyst has been obtained from the studies of the physical properties of catalysts. Great specificity of catalysts can only mean that specific chemical properties of catalysts are involved in catalytic action. The thought underlying the work is that significant information on catalysts can be obtained from studies of the type and amount of various substances that react readily with the catalyst. The present paper describes a portion of the results of such work. Basic organic nitrogen compounds, such as quinoline, are held on silica-alumina catalyst surfaces by physical and chemical forces. These forces are widely different and at 250-500° C. the physically-held quinoline can be distinguished from the chemically-held quinoline. The physically-held increases with increase in partial pressure. The chemically-held is decreased with increase in temperature. The cracking activity of the catalysts studied was proportional to their capacity to chemisorb quinoline at cracking temperatures. Catalysts that have basic nitrogen compounds chemisorbed or that have potassium added by base exchange are poisoned for cracking. From a study of partial poisoning, an exponential relationship was found between the amount of certain nitrogen compounds chemisorbed and the yield benzene from the dealkylation of cumene. A relatively small fraction of the total surface of silica-metal oxide cracking catalysts is reponsible for the catalytic activity. Chemical properties of this part of the surface identify the active agent as an "acid."

Chemistry of Clay Cracking Catalysts. CHARLES L. THOMAS, JOHN HICKEY AND GLEN STECKER. *Ind. Eng. Chem.*, **42** (1950), pp. 866-71.

Clays of the montmorillonite type are the basic materials for the so-called "natural" catalysts for petroleum cracking. Acid treating of these clays increases their catalytic activity to a maximum, but treatment with further acid decreases the activity. The acid treatment removes metallic atoms (mostly aluminum) from the central layer of the montmorillonite crystal. These metallic atoms are in octahedral coordination with oxygen atoms held by the silicon atoms. The authors suggest that the removal of one of a pair of octahedral atoms removes two hydroxyl groups, leaving the remaining metallic atom of the pair in tetrahedral coordination. The change from octahedral to tetrahedral coordination leaves the crystal lattice with a negative charge balanced by a hydrogen ion. They further suggest that this hydrogen ion is the cause of the catalytic activity. Data are presented to show the correlation between the acidity of the catalysts and catalytic activity. The hydrocarbon reactions affected by the catalysts are considered to follow a carbonium ion mechanism. The data are presented in tabular and graphical form and a bibliography of 17 references is included.

Cyclic Polyolefins. IV. 1,3-Cyclooctadiene. ARTHUR C. COPE AND LELAND L. ESTES JR. *Jour. Am. Chem. Soc.*, **72** (1950), pp. 1128-32.

Cyclooctene, prepared by the partial hydrogenation of cyclooctatetraene, was



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converted to 3-bromocyclooctene and a dibromide by bromination with N-bromosyccinimide. 1,3-Cyclooctadiene was prepared from 3-bromocyclooctene by conversion to 1-dimethylamino-3-cyclooctene followed by application of exhaustive methylation, and also by direct debromination with quinoline.

Gaseous Detonations. II. Initiation by Shock Waves. DONALD J. BERETS, EDWARD F. GREENE, AND G. B. KISTIAKOWSKY. *Jour. Am. Chem. Soc.*, **72** (1950), pp. 1086-91.

The authors discuss the sequence of events that follows when gaseous mixtures are thermally ignited starting with a flame that propagates with subsonic speed and ending with detonation. The detonation wave apparently originates spontaneously some distance ahead of the flame front. The place of origin coincides with the location of a shock wave sent out by the expanding gases of the flame. Intense shock waves appear to start detonation instantly. Weaker shocks cause ignition that eventually changes into detonation. The paper describes experiments on the initiation of gaseous detonations by plane shock waves transmitted by inert gases. The experiments conducted provide information on the course of events when shock waves of controlled intensity enter variously composed mixtures of acetylene and oxygen, hydrogen and oxygen, methane and oxygen, and benzene and oxygen.

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Products: Properties, Utilization and Analysis

Mechanical Properties of Polyethylene. R. H. CAREY, E. F. SCHULZ, AND G. J. DIENES. *Ind. Eng. Chem.*, **42** (1950), pp. 842-7.

The authors describe an investigation of the fundamental and practical mechanical properties of various molecular weight polyethylene resins by means of tensile stress-strain and torsional torque-deflection curves. By combining the two techniques, stiffness properties have been evaluated over an unusually wide range of temperature. Other mechanical properties, such as stress and strain at the "elastic limit," and energy of strain can also be evaluated on the basis of these data. It was found that the product of the initial modulus and the strain at the elestic limit are proportional to the stress at the elastic limit. On the basis of this principle a clear picture of most of the mechanical properties of the compounds has been attained.

Sulfur Compounds from Petroleum Hydrocarbons. W. A. SCHULZE, G. H. SHORT, AND W. W. CROUCH. *Ind. Eng. Chem.*, **42** (1950), pp. 916-21.

A family of tertiary aliphatic mercaptans, or thiols, are now commercially available, including members with 4 to 16 carbon atoms, and are made by the catalytic addition of hydrogen sulfied to olefinic hydrocarbons of petroleum origin. The paper presents the results of research concerning applications of the tertiary aliphatic mercaptans, and describes some of the more interesting reactions as well as a number of new compounds that have been prepared. Such products include tertiary aliphatic disulfides, polysulfides, trithiocarbonates, sulfenamides, alkylsulfenyl dithiocarbamates, alkylmercapto polyether alcohols, mercaptals, phosphorus thio esters, and various metal mercaptides. Some applications are discussed, such as lubricant additives, ore flotation collectors, vulcanization accelerators, fungicides, and nonionic detergents.

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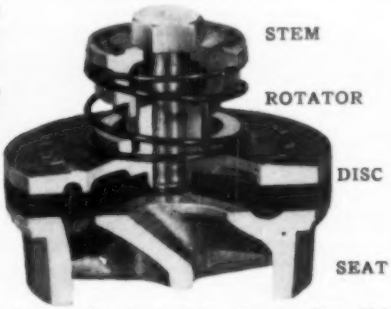

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Effect of Higher Temperatures on Tube Life

In general, corrosion reactions are speeded up by a rise in temperature. Tests conducted in 3% sodium chloride solutions revealed that the depth of pitting doubles for each 20° C. rise in temperature in the range of 18° to 75° C. The effect of temperature on corrosion rate is influenced by the nature of the corrosion medium—water or other liquid, or gas—and the character of the metal or alloy in contact with this medium.

Why Warm Waters Are More Corrosive

In sea water, a small rise in temperature often leads to a higher rate of corrosion, resulting primarily from greatly increased bacterial activity. With higher temperatures, organic decomposition is more active resulting in the generation of hydrogen sulphide and other odoriferous sulphur and nitrogenous compounds. The presence of even a trace of hydrogen sulphide accelerates the rate of impingement corrosion and changes the character of films of corrosion products.

Records clearly indicate that tube failures during warm seasons, in some localities, are far greater than those encountered during the winter. Condenser tubes installed during the summer often do not develop a satisfactory protective film and consequently may fail prematurely.

Protection By Scale Formation

In fresh waters, higher temperatures may be responsible for reducing the corrosion rate. With rise in temperature, certain waters precipitate minerals forming a brown or gray protective scale on the tube surfaces in water heaters, exchangers and evaporators. The scale, essentially of calcium carbonate or silicate, may become quite thick.

Evaporation of sea water and fresh waters may lead to concentration of mineral matter to a point where precipitation of thick mineral scales occurs which may build up at rates as high as 0.0625" per month or even higher depending upon the size of coil and amount of water being evaporated. Unfortunately, excessively thick mineral scales interfere with heat transfer properties and must be removed.

Hot Wall Effect

Sometimes severe local corrosion or pitting can rapidly perforate heat exchange tubing on the water or liquid side. Air bubbles or debris separating from the water cling to the metal surface at certain points and act as heat insulators thus allowing small areas to become hotter locally, approaching the temperature of the hot liquid or gas on the other side of the tube wall. Corrosion at these points proceeds at a rate corresponding with this higher temperature. This accelerated corrosion rate is not encountered where the tube surfaces are kept smooth and clean.

Suggested preventive measures are:

Lower operating temperatures.

Clean tubes immediately when water carries in much debris, mud, silt, rust, etc.

Increase water velocity to help dislodge debris and bubbles of gas.

Feed Water Heaters

Because of the less corrosive nature of the water and the small amount of mineral matter, serious scale formation or deposits are not generally formed in feed water heater tubes. The chief effect of the higher temperature is to lower the physical properties of the metal and increase the creep rate. Higher pressures and temperatures can be handled by tubing with heavier wall thicknesses designed for such service. Cupro Nickel (70-30), because of its low creep rate at higher temperatures, is popular for use in feed water heaters which operate between 500°-600° F.

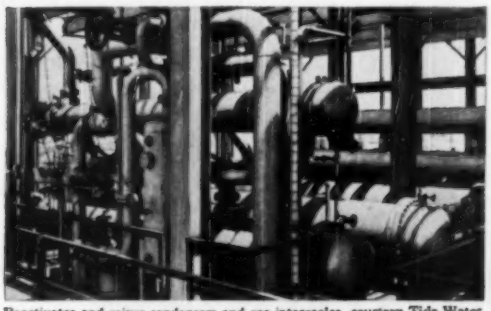
Performance Records Important

We find that more and more engineers in oil refineries and power plants are keeping careful records of tube life on each condenser and heat exchanger in their plants. Often special units are operated with experimental tubing and piped so that they can be by-passed in order to study the effects of corrosion.

If tubes fail prematurely then studies are immediately started to determine whether the correct alloy has been selected or whether changes in the operating procedures must be made.

Whereas the Admiralty alloy was formerly standard for practically all oil refineries, many are now using Aluminum Brass, Aluminum Bronze or Cupro Nickel, especially if the plants are located on the seaboard where corrosion is excessive.

Engineers who need help on their tube problems can call on Bridgeport's corrosion laboratory. Much information can also be found in Bridgeport's "Condenser Tube Manual" and "Duplex Tubing Technical Bulletin No. 1950", available upon request made on company stationery.



Reactivator and mixer condensers and gas intercooler, courtesy Tide Water Associated Oil Company, Bayonne, N. J.

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Digest of Recent U. S. PATENTS Pertaining to PETROLEUM REFINING

Compiled by HEINZ HEINEMANN

(From the Official Gazette, April 18, 25 and May 2, 9, 1950)

CATALYST PREPARATION, ACTIVATION, AND REGENERATION

U.S.P. 2,504,102. Method of Revivifying Sulfur Killed Catalysts. E. J. R. Sorf to Socony-Vacuum Oil Company, Inc.

Clay-type catalysts de-activated in cyclic hydrocarbon conversion systems by contact with S-bearing hydrocarbon reactants are revivified by subjecting them, after removal of the carbonaceous deposits by burning, to a temperature of 1050-1425° F. for a period of at least five hours in an atmosphere of low moisture content.

U.S.P. 2,505,263. Method of Regenerating a Fixed Bed Catalyst. H. D. Trotter to Phillips Petroleum Company.

In the regeneration of fixed bed catalysts by combustion of carbonaceous deposits with oxygen-containing gas passed longitudinally through the catalyst bed, this gas is passed until free oxygen begins to appear in the effluent. An additional stream of such gas is then introduced directly into the zone of still uncombusted deposits, and the flow of both gas streams is continued until uniform reactivation is completed.

U.S.P. 2,505,895. Catalyst Preparation. L. Heard to Standard Oil Company of Indiana.

Gel catalysts in the form of discrete rounded particles are prepared by dispersing hydrosol stable for about one minute in the form of droplets in a coagulating bath incompletely miscible with water. The gelation of the droplets within the bath is accelerated by passing a dehydrating current of drying gas therethrough in the presence of the droplets.

U.S.P. 2,506,302. Method for Regeneration of a Hydrocarbon Synthesis Catalyst. R. W. Krebs to Standard Oil Development Company.

In the regeneration of a Fischer-Tropsch synthesis catalyst, the carbonized catalyst is contacted with a metal oxide reducible by carbon at a temperature below the fusion point of the catalyst, e.g. with an oxide of Cr, Mo, V, or Cu at a temperature conducive to a reaction of the oxygen of this metal oxide with carbon on the carbonized catalyst to form carbon oxides and decarbonize the catalyst.

U.S.P. 2,506,316. Forming Hydrogel Beads by Spray Contact. J. A. Pierce to Standard Oil Development Company.

Separate sprays of solutions of sodium silicates and of an aluminum salt are mixed. The resulting sol particles are maintained in disperse phase to effect gelation. The minute spheres of silica alumina hydrogel formed are collected. The method is useful also in the preparation of other spherical hydrogel particles.

U.S.P. 2,506,542. Method and Apparatus for Regeneration of Finely Divided Adsorbents. H. P. Caldwell Jr., and J. W. Payne to Socony-Vacuum Oil Company, Inc.

A finely divided adsorbent material bearing carbonaceous contaminant, e.g. a spent hydrocarbon conversion catalyst or a hydrocarbon decolorizing material, is revivified by a method claimed in detail. This method permits satisfactory removal of the contaminant without overheating of the adsorbent treated, such as clay. A substantial portion of the heat liberated in the contaminant combustion is utilized for preheating the spent adsorbent to temperatures which will effect distillation of volatile contaminant constituents.

U.S.P. 2,506,545. Method for Regenerating Spent Contact Mass Material. J. A. Crowley Jr. to Socony-Vacuum Oil Company, Inc.

Spent particle form, inorganic solid adsorbent material containing carbonaceous contaminants, such as spent petroleum percolation adsorbent, is mixed at atmospheric temperature with at least partially regenerated adsorbent sufficiently hot to raise the temperature of the spent adsorbent to a temperature suitable for initiating contaminant combustion. Further details of the regenerating process are claimed.

U.S.P. 2,506,552. Method of Regenerating Spent Contact Mass Material. T. P. Simpson to Socony-Vacuum Oil Company, Inc.

Details are claimed of a method for regenerating by burning spent contact masses containing heavy carbonaceous contaminants, such as petroleum percolation adsorbents, with a carbon content of more than 4 percent by weight of the adsorbent. The method is closely related to that of U.S.P. 2,506,545.

REFINING

U.S.P. 2,504,134. Deleading of Gasoline. M. S. Kharasch to the U. S. Secretary of the Army.

Gasoline which contains tetraethyl lead is deleaded by the addition of a perhydrohalide of a tert. amine and subsequent treatment of the resulting mixture with charcoal, which adsorbs the reaction product and settles it out.

U.S.P. 2,504,429. Recovery of Hydrocarbons from Natural Gas. J. W. Latchum Jr. to Phillips Petroleum Company.

Details are claimed of a process for treating natural gas to recover natural gasoline therefrom by contact with an absorption oil.

U.S.P. 2,504,830. Recovery of Ortho-Xylene by Chemical Treatment and Distillation. R. B. Greene to Allied Chemical & Dye Corporation.

Details are claimed of a process for the recovery of pure o-xylene from drip oil, i.e., a mixture of aromatic hydrocarbons and like-boiling non-aromatic hydrocarbons as obtained from carburetted water gas. Methyl ether of ethylene glycol is employed as an azeotrope former in the distillation of the o-xylene fraction of the oil.

U.S.P. 2,505,752. Separation of Organic Compounds. W. P. Burton to The M. W. Kellogg Company.

A mixture of hydrocarbons and water-soluble, and oil-soluble oxygenated organic compounds as obtained in a Fischer-Tropsch synthesis is cooled to form and separate an oil product liquid phase and a water product liquid phase. The oily liquid phase is then extracted with a polar solvent for oxygenated compounds. A raffinate comprising hydrocarbons and an extract comprising water-soluble oxygenated compounds are thus obtained. The extract is combined with the water product liquid phase to produce a mixture comprising organic acids and non-acidic compounds which are thereafter separated.

U.S.P. 2,505,824-5. Process for Breaking Petroleum Emulsions. M. DeGroote and B. Keiser to Petrolite Corporation, Ltd.

Petroleum emulsions of the water-in-oil type are subjected to the action of a demulsifying agent comprising a hydrophile pyrolytic esterification product obtained by reaction between a certain type of acidic triricinoleic ester or acidic ricinoleic acid-polycarboxylic acid-glycerol ester, and a certain type of polyalky-

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Patents

lene glycol in a process claimed in detail.

U.S.P. 2,506,089. Diesel Fuel. M. P. Kleinholz to Sinclair Refining Company.

A diesel fuel consists of a hydrocarbon diesel oil blended with a cetane number improving quantity (e.g. 0.25-2 percent) of a polyolefin derived by polymerization of refinery cracked gases which has been sulfurized with elemental sulfur in a proportion of 5-30 percent on the charge and at a temperature of 275-400° F.

U.S.P. 2,506,289. Process for the Separation of Isomers. L. K. Beach, J. F. Nelson, and J. Stewart to Standard Oil Development Company.

A mixture of isomeric polyalkyl benzenoid hydrocarbons including o-, m-, and p-isomers is selectively reacted with mercuric acetate. The m-isomers preferentially form compounds with this reagent, while the o- and p-isomers remain essentially unreacted. After separation of the o- and p-hydrocarbons, the nonvolatile mercuric acetate compounds formed are decomposed to regenerate the separated m-hydrocarbons.

U.S.P. 2,506,847. Stabilized Motor Fuel. T. B. Tom to Standard Oil Company (Indiana.)

A hydrocarbon motor fuel contains 0.005-0.5 percent of an organo arsonic acid of the formula $RAsO(OH)_2$, wherein R in an aliphatic or aromatic radical, oxidative deterioration of the fuel is inhibited by the additive.

U.S.P. 2,506,858. Azeotropic Distillation of Hydrocarbons with Tetrahydrofuran. M. W. Davidson to Phillips Petroleum Company.

A narrow boiling range mixture of saturated and aromatic hydrocarbons boiling between 65-125° C. is azeotropically distilled in the presence of tetrahydrofuran. A low-boiling fraction enriched in saturated hydrocarbons and a high-boiling fraction enriched in aromatics are obtained.

CRACKING AND REFORMING

U.S.P. 2,504,158. Hydrocarbon Conversion with Eccles Kaolin. H. A. Shabaker to Houdry Process Corporation.

Hydrocarbons are contacted with Eccles kaolin under cracking conditions. The Eccles kaolin shall contain on a dry weight basis 43-47 percent SiO_2 and 41-35 percent Al_2O_3. The remaining constituents exclusive of volatiles shall constitute less than 2.5 percent of the total clay composition.

U.S.P. 2,504,415. Catalytic Cracking and Reforming Process. H. J. Hepp to Phillips Petroleum Company.

Details are claimed of a process for the manufacture of motor fuels by the catalytic cracking and reforming of a mixture of a refractory gas oil and a naphtha.

U.S.P. 2,506,291. Catalytic Conversion of Hydrocarbons. F. H. Blanding to Standard Oil Development Company.

Details are claimed of a process for catalytic cracking of hydrocarbons to

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U.S.P. 2,506,923. Conversion of Hydrocarbons with Silica-Alumina Catalyst. J. Hoekstra to Universal Oil Products Company.

Hydrocarbons are cracked in contact with a catalyst prepared from a synthetic composite of a major proportion of silica and a minor proportion of alumina by treatment with HF in an amount not greater than 20 percent by weight of the catalyst.

U.S.P. 2,507,220. Catalytic Conversion of Hydrocarbons. H. L. Pelzer to Sinclair Refining Company.

Lighter, lower boiling hydrocarbons are produced by cracking heavier, higher boiling hydrocarbons with a catalyst consisting of anhydrous NH_4F which is admixed to the charge hydrocarbon in the liquid phase. Cracking is carried out at a temperature of 650-750° F. and at atmospheric pressure.

POLYMERIZATION AND CONVERSION

U.S.P. 2,504,215. Catalyst Chamber. W. B. Montgomery and F. Rapasky to The M. W. Kellogg Company.

Details are claimed of an apparatus for the continuous catalytic conversion of hydrocarbons by their contact with a moving mass of finely divided solid contact material. The construction of the catalyst chamber allows a constant supply of fresh catalyst material to the reactants and a constant removal of spent catalyst.

U.S.P. 2,505,850. Seal Slot for Catalyst Bed Screens in Catalyst Chambers. P. P. Briggs to Phillips Petroleum Company.

A vessel for contacting a fluid with a solid material, such as a catalyst, has a solid material support formed by a refractory insulation lining of the vessel. This support includes a screen member with a circumferential slot recessed in the lining for tightly sealing the outer edge of the supporting screen for the catalyst, in order to prevent leakage of catalyst around the screen edge.

U.S.P. 2,505,851. Catalyst Vessel. B. E. Wohker and P. P. Briggs to Phillips Petroleum Company.

The construction of a catalyst chamber for high temperature service is claimed, adapted particularly for processing hydrocarbons at high temperature with intermittent catalyst regeneration.

U.S.P. 2,505,871. Process for Continuously Heating Hydrocarbon Fluids. H. D. Trotter to Phillips Petroleum Company.

Details are claimed of a process for continuously heating and converting a hydrocarbon oil in the presence of a granular fixed bed catalyst and for the regeneration of this catalyst by burning carbonaceous deposits during the continuous process.

U.S.P. 2,506,122. Catalytic Conversion of Hydrocarbons and Regeneration of Fouled Catalyst in Stages. K.-M. Watson to Sinclair Refining Company.

Details are claimed of a process for the continuous pyrolytic conversion of hydrocarbons in vapor phase in the presence of a solid catalyst which is intermittently regenerated. The catalyst is caused to gravitate as a continuous vertical bed downward through a chamber with at least one relatively narrow horizontal dimension. The hydrocarbon vapors are repeatedly passed transversely through the catalyst body.

U.S.P. 2,506,123. Apparatus for Pyrolytic Conversion of Hydrocarbons. K. M. Watson to Sinclair Refining Company.

An apparatus is claimed which is especially adapted to the carrying out of the process claimed in U.S.P. 2,506,122.

U.S.P. 2,506,307. Contacting Gaseous Fluids and Solid Particles. H. Z. Martin to Standard Oil Development Company.

Details are claimed of a process and an apparatus for carrying out catalytic reactions involving the production of hydrocarbons of relatively low boiling

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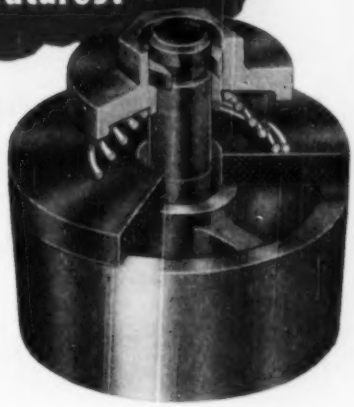

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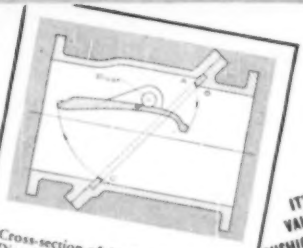

Cross-section of the Chapman Tilting Disc Check Valve illustrating the way that the balanced disc is supported on the pivot, with arrows showing the travel of the disc. A feature of the design is that the disc seat lifts away from the body seat when opening, and drops into contact when closing, with no sliding or wearing of the seats.

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point, e.g., for cracking operations. The finely divided solid catalyst employed is regenerated after use and utilized without previous cooling for vaporizing the hydrocarbon feed and supplying the heat of reaction for the vaporized hydrocarbons in the presence of the regenerated catalyst.

U.S.P. 2,506,317. Removal of Heat from Finely Divided Solids. W. A. Rex to Standard Oil Development Company.

Details are claimed of a process for cooling hot, subdivided solids, e.g., for the cooling of carbonaceous shale obtained as a residue in the distillation of oil shale.

U.S.P. 2,506,720. Hydrocarbon Conversion with Metal Halide Catalysts. H. H. Jones to Phillips Petroleum Company.

In the vapor-phase conversion of hydrocarbons, e.g., the isomerization of normal butane, over a supported Friedel-Crafts metal halide catalyst wherein the reaction is periodically stopped when the per-pass conversion falls to a predetermined minimum and the catalyst is then reactivated by addition of metal halide, the flow of hydrocarbon vapors is initiated at conversion conditions over a freshly-reactivated catalyst at a flow rate substantially below that which is optimum for the greater part of the conversion period. The low flow rate is continued until the per-pass conversion increases to the minimum value, and is then increased to said optimum rate for the balance of the conversion period.

U.S.P. 2,506,857. Mass Polymerization. W. W. Crouch to Phillips Petroleum Company.

Conjugated diolefins are polymerized in the presence of a finely divided alkali metal catalyst in admixture with 50-400 parts by weight of a low boiling diluent and 0.5-10 parts of a surface active agent per 100 parts of the diolefin. An alkaline earth metal salt of a fatty acid with 12-20 atoms is employed as the surface active agent.

U.S.P. 2,507,105. Process for the Friedel-Crafts Catalyzed Low Temperature Polymerization of Isoolefins. F. A. Howard and A. D. Green to Standard Oil Development Company.

Details are claimed of a process for preparing olefinic polymers in the presence of a Friedel-Crafts metal halide catalyst at temperatures of —10° F. to —164° C. with accurate control of the reaction and decrease of the tendency to equipment plugging and to skin formation on cooling surfaces. The catalyst is introduced into the reactor in such a manner as to effect dispersal thereof throughout a limited part of the reaction mixture or slurry, in order to avoid immediate, excessive dilution of the catalyst. Faster reaction and higher yields are effected.

U.S.P. 2,507,338. Polymerization of Alpha Alkyl Styrenes. R. G. Heiligmann to The Atlantic Refining Company.

Alpha alkyl styrenes with not more than 3 C atoms in the alkyl group are homopolymerized to form solid resins with a mol. wt. of at least 21,000 by con-

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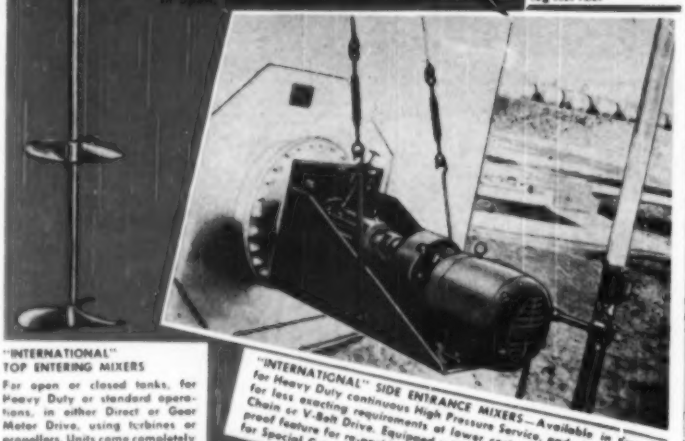

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tacting a solution of the alkyl styrene in 6-25 volumes of liquefied normal monoolefin having 2-4 C atoms with a Friedel-Crafts catalyst at a temperature of —50° to —100° C.

HYDROGENATION, DEHYDROGENATION, AROMATIZATION

U.S.P. 2,506,065. Production of Diolefins and Motor Fuel from Carbon Monoxide and Hydrogen. A. Clark to Phillips Petroleum Company.

The effluent of a Fischer-Tropsch synthesis process is separated into a hydrocarbon and an aqueous phase containing organic oxygen compounds. A fraction containing these compounds and not more than 25 percent water is recovered from the aqueous phase and contacted with a suitable catalyst (e.g., MgO-silica) at reaction conditions to produce a diolefin containing effluent. The diolefins are recovered. At least a portion of the remaining high-boiling materials from this effluent and the gasoline hydrocarbons from the Fischer-Tropsch synthesis are contacted with a suitable catalyst (e.g., dehydrated bauxite) at reaction conditions to remove organically combined oxygen and isomerize olefins.

U.S.P. 2,506,221. Catalytic Synthesis of Hydrocarbons. P. C. Keith to Hydrocarbon Research, Inc.

Details are claimed of a Fischer-Tropsch synthesis process. The vertical catalytic chamber is subdivided into a plurality of independent zones containing a dense fluid phase of powdered catalyst, and through which zones a portion of the feed gas is successively passed, preferably in admixture with recycling gases from the process. An increment of additional fresh feed gas is introduced into each of the restricted flow spaces connecting the independent reaction zones.

U.S.P. 2,506,226. Stainless Steel Catalyst for Hydrocarbon Synthesis. E. T. Layng to Hydrocarbon Research, Inc.

A CO/H_2 mixture is passed in contact with a finely divided solid particle catalyst comprising stainless steel containing 4-30 percent Cr and 4-8 percent Ni at a temperature of 550-700° F. and a pressure of less than 1000 psi. Liquid hydrocarbons predominantly boiling in the gasoline range are obtained.

ISOMERIZATION

U.S.P. 2,504,280. Isomerization of Light Hydrocarbons. B. H. Shoemaker and B. L. Evering to Standard Oil Company of Indiana.

A normally liquid paraffin hydrocarbon of the gasoline boiling range is contacted in the liquid phase with at least an equal weight of liquid anhydrous HF catalyst at a temperature of 150-500° F. under a pressure sufficient to maintain the materials in the liquid phase. Aromatic hydrocarbon in an amount sufficient to inhibit cracking but insufficient

to inhibit isomerization is admixed. The paraffin hydrocarbon is isomerized.

U.S.P. 2,504,464. Method for Control of Distillation Columns. C. P. Stanley to Phillips Petroleum Company.

Details are claimed of a process for stripping from a hydrocarbon a non-hydrocarbon material which is to be separated from a hydrocarbon isomerization effluent, such as HCl. The process allows accurate control of distillation and stripping columns.

U.S.P. 2,505,792. Cyclohexane Production. W. E. Ross and P. Pezzaglia to Shell Development Company.

Details are claimed of a process for the production of cyclohexane substantially free of benzene from a mixture of methylcyclopentane which is isomerized in the process, and open chain hexanes of normal and branched structure and benzene.

ALKYLATION

U.S.P. 2,505,644 Production of Motor Fuels by Alkylation. S. H. McAllister and E. F. Bullard to Shell Development Company.

High anti-knock motor fuel constituents boiling in the aviation gasoline boiling range are manufactured from a mixture of isobutane and n-butane or from cracking still gases containing a mixture of isoparaffin, n-paraffin, and olefin. The isoparaffin in the mixture is alkylated with olefin by contact with H_2SO_4 of suitable strength. The ratio of isoparaffin to olefin at the point where the olefin initially contacts the catalyst is maintained above 100:1.

U.S.P. 2,506,551. Alkylation of Benzene. A. N. Sachanen and P. D. Caesar to Socony-Vacuum Oil Company, Inc.

Benzene is contacted with an alkyl chloride having at least 2 C atoms at a temperature of 400-700° F. and a pressure of at least 200 psi. for a period of time of at least one minute. Alkylation of the benzene is effected.

HEAVY OILS AND WAXES

U.S.P. 2,504,270. Method of Preparing Polyethylene Wax Compositions. F. H. McLaren and J. A. Anderson to Standard Oil Company of Indiana.

A homogenous blend is formed from 5-60 percent of a petroleum wax and an ethylene polymer with an average mol wt. of 5000-25,000 at a temperature of 220-360° F. The resulting blend is dissolved in petroleum wax at a temperature of 140-250° F. The ethylene polymer (preferably about 0.001-0.2 percent of the final composition) is completely dissolved in the petroleum wax. The composition is stable, homogenous, and has high tensile strength.

U.S.P. 2,504,400. Production of Polyethylene Waxes. M. Erchak, Jr., to Allied Chemical & Dye Corporation.

Ethylene is maintained under pressures of 425-475 atms. and at temperatures of 140-200° C. in contact with iso-

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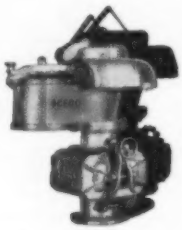

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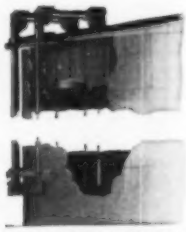

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propanol in an amount sufficient to occupy 5-10 percent of the total volume of the reaction zone and with 0.1-2 percent by weight on the isopropanol of H_2O_2 on a 100 percent H_2O_2 basis. An at least medium hard high melting wax is obtained.

U.S.P. 2,504,672. Lithium Grease. B. B. Farrington and F. A. Leyda to California Research Corporation.

A lubricating grease comprises a mineral lubricating oil, a lithium soap for thickening the oil, and 0.1-1 percent of zinc dialkyl dithiocarbomate. This additive inhibits the deterioration of the lithium base grease.

U.S.P. 2,504,717. Reversible Lubricating Grease Composition. A. J. Morway and J. C. Zimmer to Standard Oil Development Company.

A mineral base lubricating oil is heated with a saponifiable aliphatic fatty material to saponification temperature. $Ba(OH)_2$ is introduced in quantity not exceeding stoichiometrical proportions to saponify the fatty material in situ. The $Ba(OH)_2$ shall be substantially free of carbonate. A smooth solid homogeneous reversible lubricating grease is produced.

U.S.P. 2,504,742-3. Antioxidants for Mineral Oil Lubricants and Compositions Containing the Same. H. G. Smith, T. L. Cantrell, and J. G. Peters to Gulf Oil Corporation.

A mineral lubricating oil is compounded with a minor amount of a nonresinous condensation product of 1-4 mols of a monohydric phenol, 1-4 mols of N-dimethylaniline, and 0.5-4 mols of formaldehyde per mol of the phenol. Details of the condensation reaction are also claimed. The additive inhibits oxidative deterioration of the oil. According to U.S.P. 2,540,743, p-hydroxydiphenyl can be employed as the phenol component.

U.S.P. 2,504,779. Lubricating Grease. D. W. Young and W. H. Smyers to Standard Oil Development Company.

A lubricating grease consists of 67-94 percent by weight of mineral lubricating oil, 5-30 percent of a thickener, and 1-3 percent of a "cycalkene" copolymer (copolymers of aliphatic monoolefins and aromatic olefins) containing 40-65 percent of the cyclic component and having an intrinsic viscosity above 0.5.

U.S.P. 2,505,222. Grease. A. W. Weitkamp and J. C. Stamm to Standard Oil Company of Indiana.

A rosin soap grease is prepared by heating a mixture of a hydrocarbon oil, rosin, and a certain modified rosin at a temperature of 150-300° F. The solution thus formed is saponified by an alkali or alkaline earth metal base or a mixture thereof.

U.S.P. 2,506,049. Lubricant. G. R. Waitkins to Battelle Memorial Institute.

A major amount of a mineral oil is compounded with a minor amount of an alkyl, alkaryl, aralkyl, or aryl selenonophosphate. The additive effects stabilization of the oil against oxidation.

U.S.P. 2,506,059. Wax Compositions. J. R. Bowman and W. P. Ridenour to

R-S valvEvents

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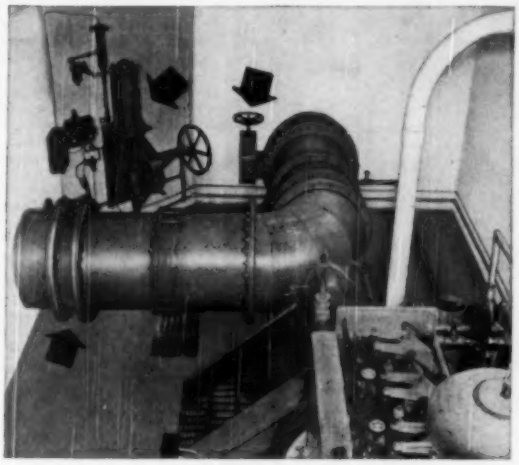

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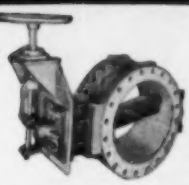
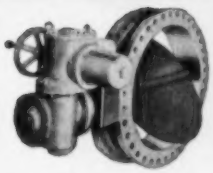
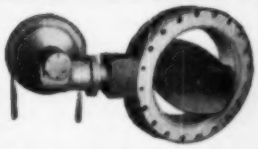


No. 700—20-inch 50-pound Cast Iron Valve with rubber seat, Type B-8934, for positive 100% shut-off. Heavy duty handwheel control with threaded reach rod. Type B-9469.

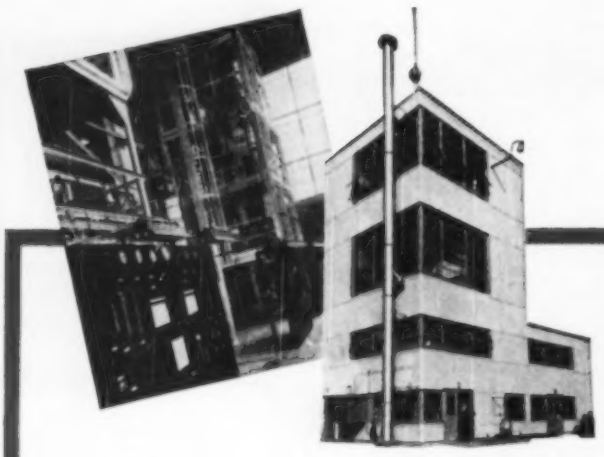


No. 724—42-inch 50-pound Heavy Service Valve, B-9813, complete with limitorque motor and gear reduction drive No. 4. Angular seating vane for wedge-type closure with metal seat. Rubber seat available if desired. Valve body good for 125 psi gauge static head and drip tight shut-off at 50 psi pressure drop with rubber seat.

No. 768—66-inch Fabricated Steel Handwheel Operated Valve with ends straffed for welding. 6½-inch diameter one piece Stainless Steel shaft mounted on thrust bearings (valve installed with shaft vertical). Horizental and vertical ribs on body prevent distortion when machining and assembling. Stuffing box easily repacked. Used to control river flow during dam construction. Open atmospheric discharge.



No. 737—20-inch 50-pound Heavy Service Valve (B9804) with rubber seat (B8934). Gear reduction drive No. 3 with chainwheel.



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Patents

Gulf Research & Development Company.

A paraffin wax composition contains 0.1-0.5 percent of an aluminum di- or tri-stearate substantially free of acid. The composition has increased tensile strength.

U.S.P. 2,506,310. Lubricating Oil Composition. L. A. Mikeska to Standard Oil Development Company.

A mineral lubricating oil contains 0.02-3 percent of a metal salt of an organo substituted thiophosphoric acid obtained by reacting P_2S_5 with a mixture of wax-phenol and an aliphatic alcohol at a temperature of 50-150° C. The amount of P_2S_5 employed shall be in a certain proportion to the hydroxyl groups in both the wax-phenol and the alcohol. The additive imparts pour stabilizing properties to the oil.

U.S.P. 2,506,570. Lubricating Oil Compositions. H. J. Andress Jr. to Socony-Vacuum Oil Company, Inc.

A mineral oil composition contains a minor proportion of an oxidation inhibiting acidic, P- and S-containing reaction product of a wax-substituted phenol prepared by a process claimed in detail.

U.S.P. 2,506,572-3. Lubricant Composition. J. D. Bartleson to The Standard Oil Company of Ohio.

A mineral oil lubricant contains an additive obtained by reacting under special conditions a phosphorous sulfide (e.g. P_2S_5) with a saturated amine having at least one hydrogen directly attached to the nitrogen and at least one radical of at least 12 C atoms, such as octadecylamine. The additive is made oil-dispersable by treatment with a nitrogen base, such as ammonia or with sulfur. According to U.S.P. 2,506,573 an unsaturated amine with 12-18 C atoms is employed instead of the saturated amine and an element of the sulfur family (S, Se or Te) is added in the reaction.

U.S.P. 2,506,597. Lubricants. E. C. Hughes and J. D. Bartleson to The Standard Oil Company of Ohio.

The lubricant according to this patent is closely related to that of U.S.P. 2,506,573. A saturated aliphatic ketone with at least 12 C atoms is employed instead of the unsaturated amine.

U.S.P. 2,506,900. Process for Preparing Addition Agents for Mineral Oil Lubricants, the Agents so Obtained, and Mineral Oil Lubricants Containing Them. H. G. Smith, T. L. Cantrell and J. G. Peters to Gulf Oil Corporation.

A mineral lubricating oil contains a minor amount of a simultaneous reaction product of an octyl phenol with 0.5-30 percent (by weight of the latter) of a sulfur chloride and 0.1-5 percent of P_2S_5. The additive confers improved pressure-carrying, corrosion-inhibiting and detergent properties on the composition.

U.S.P. 2,506,901-2. Addition Agents for Mineral Oil Lubricants and Compositions Containing the Same. H. G. Smith, T. L. Cantrell, and J. G. Peters to Gulf Oil Corporation.

The lubricating compositions according to these patents are closely related to the composition according to U.S.P. 2,506,900. A second additive is added

beside the octyl phenol-sulfur chloride reaction product, this second additive being the condensation product of formaldehyde and a neutral aluminum or stannous salt, respectively, of the said reaction product.

U.S.P. 2,506,905-6. Stabilized Lubricating Grease Compositions. H. G. Smith and T. L. Cantrell to Gulf Research Corporation.

A mineral lubricating oil is thickened to a grease by a soap and a small amount of a neutral higher fatty mono-carboxylic acid ester of a fusible, soluble mono-alkylated phenol-formaldehyde condensation product (U.S.P. 2,506,905), or of the condensation product of formaldehyde and a higher fatty mono-carboxylic acid ester of a mono-alkylated phenol. The higher fatty acid in both cases shall be a saturated or a mono-olefinic acid with at least 8 C atoms while the alkyl group of the alkylated phenol shall have 4-12 C atoms. The additives retard oxidation of the grease.

U.S.P. 2,507,055. Addition Agents for Mineral Oils and Compositions Containing the Same. H. G. Smith, T. L. Cantrell, and J. G. Peters to Gulf Oil Corporation.

A mineral lubricating oil contains a minor amount of a phthalic acid compound or of a polyvalent metal derivative thereof, one of the hydroxyl groups of the phthalic acid being replaced by an amine group containing an alkyl or alkenyl substituent with 8-18 C atoms. The additive confers corrosion-inhibiting properties on the lubricant.

U.S.P. 2,507,103. Treatment of Contaminated Naphtha. R. L. Heinrich and H. G. Schutze to Standard Oil Development Company.

Lubricating oil is produced from naphtha boiling between 84-400° F., containing olefins and contaminated with oxygenated organic compounds and the like by subjecting the contaminated naphtha to contact with an excess of a hydrogen halide, separating the product formed from the naphtha, washing and neutralizing the latter. A fraction of the thus treated naphtha boiling in the range of the contaminated naphtha is polymerized in the presence of a Friedel-Crafts catalyst to form the lubricant.

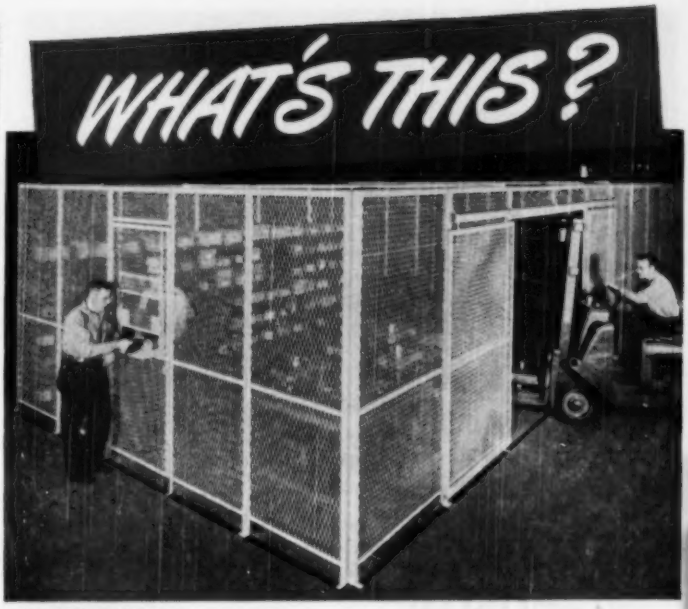
U.S.P. Re. 23,229. Compounded Lubricating Oil. J. R. Griffin Jr. and P. R. VanEss to Shell Development Company.

A lubricating oil for high temperature internal combustion engines, particularly for use in aviation, contains a small amount not exceeding 0.25 percent (based on sulfate ash) of an oil-miscible metal salt, e.g. a Ca-salt of the condensation product of an aldehyde and an aromatic hydroxy compound, and a small amount of an oil-soluble, relatively stable aromatic amine anti-oxidant. The said condensation product imparts high temperature detergent action to the lubricant.

PETROCHEMICALS

U.S.P. 2,504,411. Preparation of Alkyl Sulfonates. D. Harman to Shell Development Company.

An olefin is reacted with an equimolar



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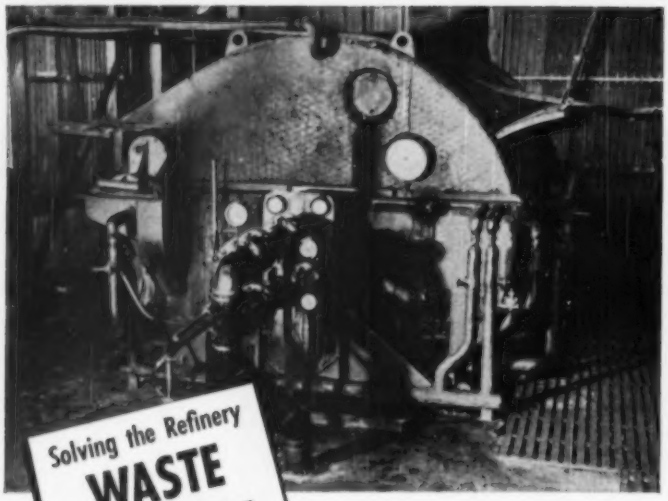

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proportion of bisulfite ions in aqueous solution at a temperature of 60-120° C. in the presence of certain reaction initiator-mutual solvent pairs claimed in detail and consisting of mixtures of certain organic peroxy compounds and a lower alcohol, pyridine or the like. Alkane sulfonates are obtained in relatively short reaction times without large excesses of bisulfite.

U.S.P. 2,504,517. Production of Cyclohexanols. R. B. Greene to Allied Chemical & Dye Corporation.

Details are claimed of a process for the production of cyclohexanol from cyclohexene by treatment with H_2SO_4 of 65-70 percent strength. Large losses of cyclohexene by polymerization and reconversion of the cyclohexanol to cyclohexene are inhibited with minimum consumption of H_2SO_4.

U.S.P. 2,504,618. Process for Producing Alcohols. R. C. Archibald and R. A. Trimble to Shell Development Company.

An olefin such as ethylene, is reacted with water, preferably at a temperature of 250-350° C., in the presence of a catalyst produced by impregnating activated montmorillonite with HF solution of 6-10 percent strength and calcining the resulting product to obtain a dry material containing 5-15 percent by weight of HF. The olefins are converted into the corresponding alcohols by direct hydration.

U.S.P. 2,504,682. Production of Oxygenated Compounds. J. T. Harlan Jr. to Shell Development Company.

Details are claimed for the synthesis of carbinols from olefins by the Oxo-process.

U.S.P. 2,504,732. Preparation of Meta-Dioxanes. R. Rosen and E. Arundale to Standard Oil Development Company.

Propylene is condensed with an aldehyde at a temperature of 65-75° C. under a pressure equal at least to the vapor pressure of the mixture in the presence of an aqueous BF_3 catalyst. The ratio of water to BF_3 in this catalyst shall be 10-18 mols of water per mol of BF_3. Metadioxanes are produced.

U.S.P. 2,505,204. Vinylthiophene Polymerization Process and Products. E. C. Pitzer to Standard Oil Company (Indiana).

A diolefinic compound (e.g. 1,3-butadiene) is emulsified with 5-90 percent of vinylthiophene in the presence of an emulsifying agent and an oxygen-disengaging polymerization catalyst. The emulsion is subjected to a temperature of 50-200° F. and pressure sufficient to maintain the liquid phase. A solid, rubber-like copolymer is separated from the emulsion.

U.S.P. 2,505,877. Vapor Phase Fluorination Process. A. F. Benning to the U. S. Atomic Energy Commission.

High boiling hydrocarbon lubricating oil in vapor phase and elemental F are passed through separate permeable masses of copper particles into separate portions of a single permeable body of a catalyst consisting of copper particles

Long life for heat exchangers starts right here!

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(*a patented alloy*)

Thousands of installations since 1935 *prove* that long service life starts with Chase Antimonial Admiralty. Here's why:

Admiralty with an antimonial content of less than .007% (the minimum set forth in Chase Patent No. 2,061,921) cannot be depended on to guard against dezincification under all conditions. For a wide range of applications, .015% is the smallest safe amount. Chase makes *sure* you get this minimum despite normal commerical variations —by using a nominal content of .035%.

That's the time-tested Antimonial Admiralty—patented by Chase, made only by Chase. Get the facts today.

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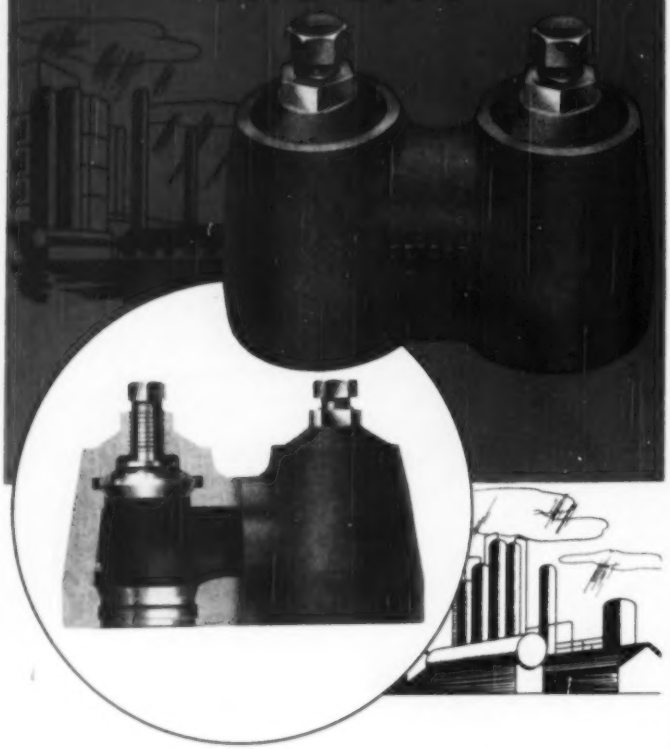
OHIO Return Bends

TYPE 3000



For several years Ohio Steel has been supplying their Type 3000 screw-lock fitting to refineries in many parts of the world. The cutaway view shows the strong, positive holding mechanism. This safe, simple assembly has a short, plug seat for easy removal. Ohio's Type 3000 is especially recommended where stainless steel is required for highly corrosive service.

The design of this fitting lends itself to Ohio's directional solidification casting principle.

THE OHIO STEEL FOUNDRY CO.

LIMA, OHIO — Plants at Lima and Springfield, Ohio

District offices in: Chicago, Cincinnati, Cleveland, Dallas, Detroit, Houston, New York, Philadelphia, Pittsburgh, San Francisco, St. Louis, Tulsa

Patents

having an AgF coating. Fluorination is effected.

U.S.P. 2,507,088. Sulfoxidation Process. H. W. Bradley to E. I. du Pont de Nemours & Company.

Saturated aliphatic hydrocarbons such as cetane are sulfoxidized by means of SO_2 and O in the presence of a Pb^{IV} salt of a saturated aliphatic mono-carboxylic acid of 2-4 C atoms, e.g., lead tetra-acetate. Sulfonic acids are obtained without requiring iridiation with ultraviolet light.

U.S.P. 2,507,471. Thiocyanate Ether of 4-Vinylcyclohexene and its Preparation. H. L. Johnson and A. P. Stuart to Sun Oil Company.

4-Vinylcyclohexene is interacted with ethylene chlorhydrin in molar proportions at elevated temperature. The resulting product is treated with an alkali metal thiocyanate in the presence of metallic copper. The product obtained has insecticide properties.

U.S.P. 2,507,472. Thiocyanoacetate Derivative of 4-Vinylcyclohexene. H. L. Johnson and A. P. Stuart to Sun Oil Company.

4-Vinylcyclohexene is esterfied with monochloracetic acid in the presence of an acid type catalyst. The resulting ester is reacted with an alkali metal thiocyanate at elevated temperature in the presence of a solvent. The resulting thiocyanoacetate derivative claimed of 4-vinylcyclohexene is useful as an insecticide.

NGAA to Meet in Tyler

The southern regional meeting of the Natural Gasoline Association of America will be held in Tyler, Texas, October 27, in cooperation with the East Texas Natural Gasoline Men's Club.

Chemicals Wanted

The National Registry of Rare Chemicals, Armour Research Foundation, 33rd, Federal and Dearborn Streets, Chicago 16, has received urgent requests for the chemicals listed below. If anyone has one or more, even if only one gram quantities, please inform the Registry.

Zinc carbonyl
Ammonium cyanide
p-Aminoethylbenzene
7-Aminobutyric acid
2-Phenylcyclohexanone
3-Methylpentanol-3
Acetyl cyanide
5-Methylisoquinoline
Acetyl phosphate
Perfluoroadipic acid
n-Decyl mercaptan
n-Hexadecyl mercaptan
Methyl vinylsulfonate
Methyl isopropenylsulfonate
Dimethyl isopropyl carbinol
Nonanetetrol-2,4,6,8
Heptanediol-2,6
3-Aminopropanol
Difluorodiiodomethane
1,6-Diphenylhexatriene-1,3,5

BOOKS

Thermodynamic Properties

Thermodynamic Properties of the Lighter Paraffin Hydrocarbons and Nitrogen, Bruce H. Sage and William N. Lacey, American Petroleum Institute, 50 West 50th Street, New York, 20. Price, $7.50.

"Thermodynamic Properties of the Lighter Paraffin Hydrocarbons and Nitrogen," a monograph, contains studies of the volumetric behavior, heat capacity, latent heat of vaporization, heat of solution, and the Joule-Thomson coefficient of the pure hydrocarbons and some two-component and three-component mixtures.

The authors are professors of chemical engineering at the California Institute of Technology, Pasadena, Calif. The work is a compilation of data resulting from API research project 37 during the period 1930-1946.

Order from Lacey Walker at the above API address.

Fire Equipment Inspection

Part III of the Recommended Practices for Refinery Inspections. American Petroleum Institute, 50 West 50th Street, New York 20. Price, $1.00.

A new handbook covering the inspection of fire protection equipment in oil refineries, under the title "Part III of the Recommended Practices for Refinery Inspection," the third part of a continuing project initiated in 1938 by the API division of refining in the interests of public safety. Three additional parts are in the process of composition, and will cover the inspection of tanks and spheroids, instruments and electrical equipment.

Order from J. A. McNally at the above API address. Parts I and II are available at $3.00 and 75 cents, respectively.

Chemical Engineers Handbook

Chemical Engineers Handbook, McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 18, 1884 pages. Price, $15.00.

The 3rd edition of Editor John H. Perry's "Chemical Engineers' Handbook" provides a virtually complete revision including a new and comprehensive coverage of both standard and recently compiled facts, figures, and methods applicable to both chemical engineering and its related fields. Several entirely new sections feature data on furnaces and kilns, size enlargement, general theory of diffusional operations, azeotropic, multi-component, extractive and molecular distillation, and dialysis. More than 2000 charts, diagrams, cross-sections, flow sheets, etc., are included with all drawings newly prepared and increased in size. An index makes use of more common words and includes their synonyms and equivalents.

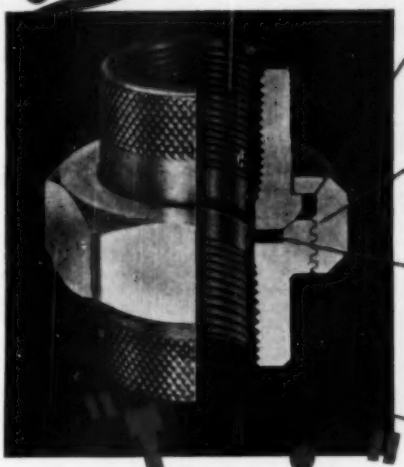
The handbook was prepared by a staff of specialists with Perry as editor. Perry is technical investigator, E. I. du Pont de Nemours and Company, Inc.

Motor-Gasoline Survey

National Motor-Gasoline Survey, Winter, 1949-50. Bureau of Mines, Publications Distribution Section, 4800

HERE'S A UNION YOU CAN USE

Over and Over Again!



BALL AND CONE SEAT
This is the same leak-proof sealing arrangement that has made WECO UNIONS leaders in the Oil Industry for 15 years

ACME THREADS . . . FASTER MAKE-UP
Fewer turns are required for seating contact of subs which draw up tighter with less pull on the wrench

RESILIENT, REPLACEABLE GASKET
Acting as supplementary seal, it protects metal-to-metal seat against abrasion and corrosion from line fluids and gases

KNURLED SUB ENDS
An exclusive feature minimizes wrench slippage, means easier, faster starting on pipe ends

WECO Junior
Fig. 342

EVEN after repeated make-up and break-out, WECO "Junior" all steel unions continue to give perfect service. The metal-to-metal ball and cone seat, meeting in a concentric circle is self-aligning and perfect seating for a leak-proof seal. The heavier wall construction of sub ends . . . the rugged nut with heavy acme threads gives them greater strength and longer life.

These 3000 lb. non-shock C.W.P. Unions are available ⅛" through 2"; machine finish or Wecolyte cadmium plated.

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ASK FOR WECO "JUNIOR" UNIONS AT YOUR INDUSTRIAL, MILL SUPPLY, OR OIL FIELD SUPPLY STORE.

Sizes ⅛ through 1" packed 24 to the carton; larger than 1" packed 12 to the carton. For adequate stocks of all sizes . . . for easier storing on warehouse and stock room shelves, order WECO "JUNIOR" UNIONS by the carton.

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Subsidiary of Chiksan Company
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LOW VISCOSITY PUMPING!

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Small Volumes at High Pressures
with SIER-BATH
ROTARY PUMPS

Sier-Bath Gearex Pump. Capacities: 1-550 GPM Discharge: 50 PSI for water

NO METALLIC CONTACT BETWEEN ROTORS!

Sier-Bath Screw Pump
Capacities: 1-700 GPM
Discharge: 250 PSI for water

LOWER ORIGINAL COST — High pressures developed by small volume Sier-Bath Pumps eliminate need for over-size pumps, expensive throttling valves. Positive displacement lessens need for costly metering valves.

LOWER OPERATING COSTS — Smaller pumps need less power. No drive-wear on rotors or casings—efficiency stays high. Positive displacement cuts labor costs, provides better control—valves, manpower can be replaced by automatic timers.

LOWER MAINTENANCE COSTS — Eliminate fast-wearing valves. Oil lubricated external bearings, no metallic contact between rotors for long, trouble-free life. Low pressure on stuffing boxes. Direct connected up to 1200 RPM. Available in corrosion-resistant alloys.

EXTERNAL BEARING TYPES (illustrated) FOR NON-LUBRICATING LIQUIDS. INTERNAL BEARING TYPES FOR LUBRICATING LIQUIDS

Also manufacturers of Sier-Bath Precision Gears and Sier-Bath Gear Couplings.

WRITE FOR BULLETINS

FOUNDED 1905 MEMBER A.G.M.A.

Sier-Bath
GEAR and PUMP CO., Inc.

9250 HUDSON BOULEVARD NORTH BERGEN, NEW JERSEY

Forbes Street, Pittsburgh 13. Free.

Motor gasolines sold at U. S. filling stations last winter had the highest octane ratings on record, according to the 1949-50 semi-annual survey of the Bureau of Mines.

Regular-price gasolines had an average octane rating (motor method) of 77.1 last winter as compared with 75.6 the preceding winter and 76.4 last summer. The average octane rating for premium-price fuels last winter was 81.2; for the 1948-49 winter the rating was 79.7 and for last summer it was 80.4.

The samples also were tested for gravity, corrosion, sulfur content, gum, tetraethyllead, Reid vapor pressure, and distillation temperatures for both regular and premium price gasolines. Comparison charts show the characteristics of motor gasolines from winter surveys of 1935-36 through 1949-50, and from summer surveys of 1936 through 1949. Material for the report was prepared by O. C. Blade, Bureau petroleum chemist.

Treatment of Problems In Temperature Control

Heat Inertia in Problems of Automatic Control of Temperature, Victor Broida, The Instruments Publishing Company, Inc., 921 Ridge Avenue, Pittsburg 12, 61 pages. Price, $1.00.

Victor Broida's book, "Heat Inertia in Problems of Automatic Control of Temperature" should provide profitable reading for those interested in an application of theory to the practical adjustment of controllers. In treating temperature control problems the author assumes that a single equivalent heat capacity is sufficient to define the system under control. His results are therefore applicable only to those problems where such an assumption is justified. Nevertheless his treatment is adequate to explain the operation and limitations of most standard industrial controllers. Furthermore, his study of the significance of records obtained from temperature controllers can lead to improved empirical techniques for adjusting actual controllers for optimum performance. The concept of heat inertia arises from treating the heat capacity as a water equivalent. The mass of the water equivalent then becomes the heat inertia.

Whether or not Broida's work represents a unique approach to temperature control can be determined by a review of the existent literature on the subject, which is now rather extensive. The book is a revision of a series of French articles published a number of years ago. This fact probably explains the lack of an up-to-date bibliography on the subject.

The reader may find Broida's book a bit difficult to follow in certain spots. If such is the case, it is due not to the difficulty of the subject but to the imperfections arising from translation from French to English. In the adaptation of the original articles to English a compromise was reached between a retention of the author's original style and a complete rewrite of the basic thoughts expressed.

This work is worthy of careful study by those who want to gain a clear understanding of temperature control problems as well as the operation and adjustment of modern industrial controllers.

Review is by Dr. James C. Mouzon, assistant for operations analysis, deputy chief of staff, Operations Department of the Air Force, Washington 25, D. C.

Books

Hot Spot Machining Report

Hot Spot Machining. Library of Congress, Photoduplication Service, Publication Board Project, Washington 25, D. C., 37 pages. Price, $2.25 in microfilm, $5 in photostart.

Additional data on hot spot machining, a completely novel approach to metal cutting, is described in reports now available according to the Office of Technical Services of the U. S. Department of Commerce. Research on hot spot machining, undertaken by Sam Tour and Company for the Navy's Bureau of Ships was directed to finding whether the energy consumed, time involved, and results achieved in machining metal stock could be substantially improved by heating the work rather than by cooling the tool.

The hot turned surfaces of the test pieces are described as noticeably superior to cold turned surfaces cut under similar conditions. Details of complete tests made with both flame-heating and electrically-induced heating are given. Photos, graphs, drawings, and tables complete the report.

Electric Instruments Manual

Manual of Electric Instruments, (GET-1087A), General Electric Company, Schenectady 5, N. Y. Price $1.00.

A new, revised edition of General Electric Company's Manual of Electric Instruments has been announced by the meter and instrument divisions. Described are the fundamentals of construction and operating principles of all major types of electric instruments. Prepared primarily for use in schools, the manual has 13 chapters explaining the fundamentals of such instruments as thermocouples, synchroscopes, frequency meters, and electric telemeters. The 150 pages are accompanied by photographs and diagrams. Added is a full reference index.

Heat Engineering Magazine

Heat Engineering. Public Relations Division, Foster Wheeler Corporation, 165 Broadway, New York 6. Free.

A special June issue marks the 25th anniversary of "Heat Engineering," a magazine published monthly by Foster Wheeler Corporation for general trade distribution and for classroom instruction in more than 100 colleges.

API Opens Film Library

A film library of five 16 millimeter sound-color films has been started by the Department of Safety of the American Petroleum Institute to help the industry's employes become more safety-conscious.

Subjects covered include first aid treatment of arterial bleeding and the dressing of cuts and open wounds; artificial respiration, the handling of dislocations, fractures, infections, and transporting the wounded; effect of heat on water in closed containers; danger of catheads used in drilling operations and precautions; and the job of handling tongs, slips, and elevators on a drilling rig.

water

can be either
PARTNER or PROBLEM
of Industry

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Hagan—glassy phosphates for the oil industry.

Hall—consultants on boiler and industrial water problems.

Buromin—water-treating chemicals, testing equipment, etc. (licensees under Hall Patents).

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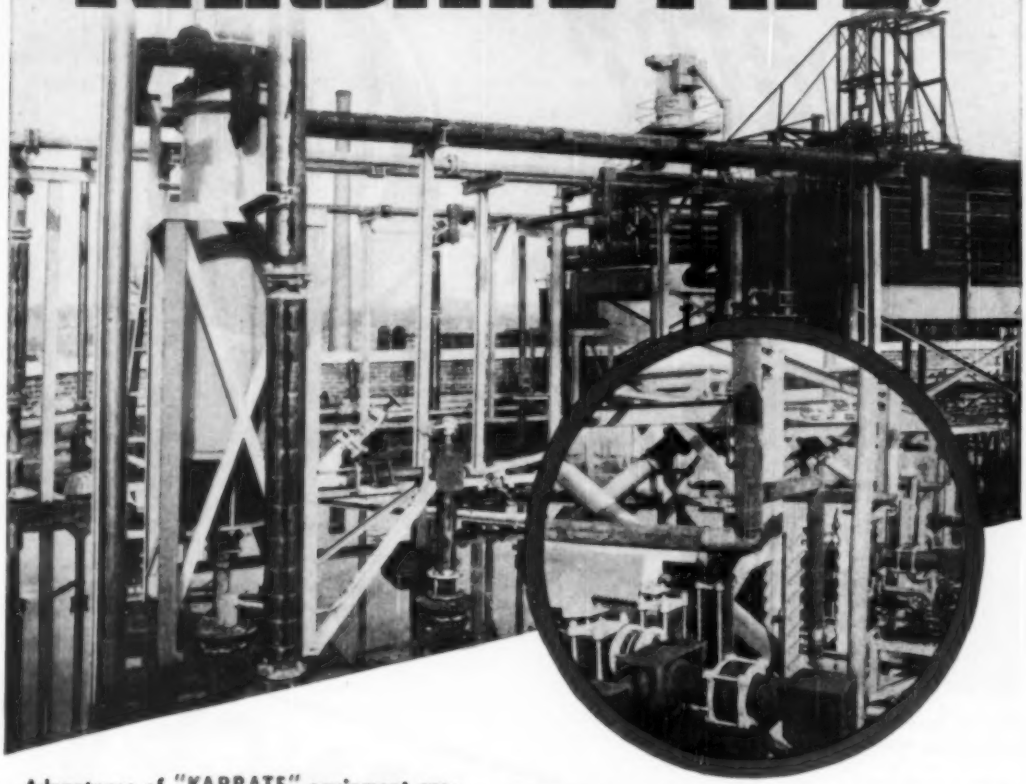
For any or all corrosive jobs...

"KARBATE" PIPE!



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- **Both acid-resistant and alkali-resistant**
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- **Immune to thermal shock**
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WHETHER your corrosion problem involves a little 100-foot "nuisance" pipe line . . . or the outfitting of a complete chemical plant, "Karbate" impervious graphite equipment offers an economical and efficient solution. "Karbate" pipe, fittings, and related equipment are the best obtainable for conveying, processing or storing practically all corrosive fluids.

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NOW... double light at no extra cost!

Specify the new and improved "Eveready" 1050 flashlight battery and you get more than double the usable brilliant white light for critical uses than is available from any other flashlight battery National Carbon has ever made. The battery is leakproof .... **NO METAL CAN TO LEAK OR CORRODE!**

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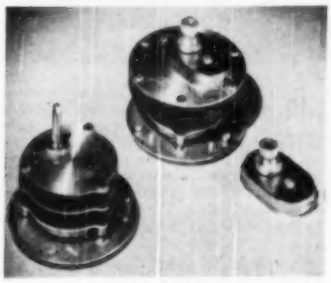
NEW EQUIPMENT and Manufacturers' Literature

For copies of manufacturers' literature or more information about products described on these pages use the coupon below, circling the number shown for each item desired.

A. C. Welder

1 A silicone-insulated, portable, a.c. welder, known as 6WK20H, has been developed by the Welding Division, General Electric Company's Apparatus Department. Unit measures 12 by 17 inches in cross section and 23 inches in height. Utilization of underbench and balcony space are permitted. Averaging one-half pound per ampere of maximum output, the welder weighs 154 pounds and has a current range from 30 to 250 amps. and accommodates electrodes from 1/16-inch diameter. Models are available for operation on 220 or 440 volts. Type WK-20, a 200-amp. transformer arc welder, is shown herewith, front view, oblique from right.

Mechanical Drives

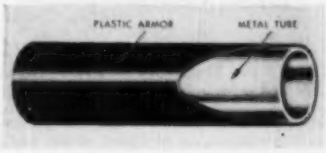


2 Two new "midget" mechanical drives for instruments, meters, and other apparatus requiring timing and characterized by a "capsulized" escapement mechanism which can be detached for service or replacement are announced by the Pittsburgh Equitable Meter Division of Rockwell Manufacturing Company. Over-all diameters are 3¼ inches and 3-3/16 inches respectively. Both models require 1-31/32 inches between the plane of the driven chart (the rotation of circular dials and recorder charts being the most common use for such mechanisms) and the mounting ring. The escapement subassembly twists and snaps into place (no tools required) and controls mainspring action through a simple connecting square.

Corrosion Control

3 "Calgon Controls Corrosion," offered by Calgon, Inc., describes the "threshold treatment" whereby minute quantities of Calgon protect industrial and other water systems against general corrosive attack, eliminate "red water," and control corrosion of hot water systems and industrial cooling systems where water temperatures accelerate attack. A graph shows influence of pH on tuberculation of black iron pipe and effect of Calgon. Also explained is corrosion at elevated temperatures.

Instrument Tubing



4 A new low-cost, corrosion-proof instrument tubing made of metal with a 1/32-inch coating of extruded thermoplastic is announced by Samuel Moore & Company in ¼ and ⅜-inch diameters. The plastic coating of Dekoron tubing is resistant to moisture, salt air, oils, acids and alkalies and can be bent like copper tubing. Literature and sample lengths of Dekoron tubing are available.

Gearmotors

5 Bulletin B250 describes Abart Gear & Machine Company's right-angle gearmotors as to sizes, ratings and prices on single-phase and three-phase models. Shown herewith is a right-angle type, with heavy duty

FOR ADDITIONAL INFORMATION on products and literature mentioned in this section circle item numbers, cut out and mail this coupon. Prompt action is suggested so that data will be readily available.

PETROLEUM REFINER
BOX 2608, HOUSTON 1, TEXAS

Please have manufacturers send me, without obligation, additional information about items from July, 1950, New Equipment Section whose numbers are circled below:

1	2	3	4	5	6	7	8	9	10	11	12
13	14	15	16	17	18	19	20	21	22	23	24
25	26	27	28	29	30	31	32	33	34	35	36
37	38	39	40	41	42	43	44	45	46	47	48
49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72
73	74	75	76	77	78	79	80	81	82	83	84
85											

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Company _____

Street address _____

City and State _____

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New Equipment

(For additional information or literature check item numbers on mailing coupon, page 185.)

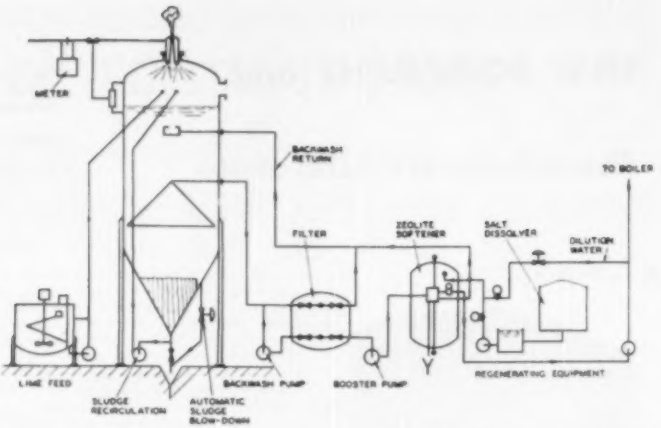
NEMA rated motor. It is rated at 1/6 to 5 hp. Ratios 5 4/5:1, to 100:1. Output speeds range from 17.5 to 302 rpm. Special voltages, cycles, etc., on application. Units can be mounted in any position. Gears are of nickel bronze, and shafts are of special tough alloy steel (180,000 to 320,000 tensile), ground.

Erecting Services

6 Ellerbee Brothers describe in a brochure their services in tank erection, industrial piping, structural steel, floating roof, steel building erection, vessels and miscellaneous refinery construction. Repairing, dismantling, and moving of tanks and pressure vessels also are covered.

Flanged Gate Valve

7 A 12-inch OS&Y corrosion-resistant flanged gate valve for 150 psi. at 500° F. (primary service rating) is announced by The Pioneer Alloy Products Company, Inc. The 12-inch unit rounds out this type of Pioneer's valve line, providing a complete range of sizes from ½ inch. Made with outside screw and yoke, the valve is available in type 302, 304, 316 stainless steel and Pioneer metal for handling specific acids and corrosive situations. The valve is said to conform to MSS standards and recently developed ASA standards.



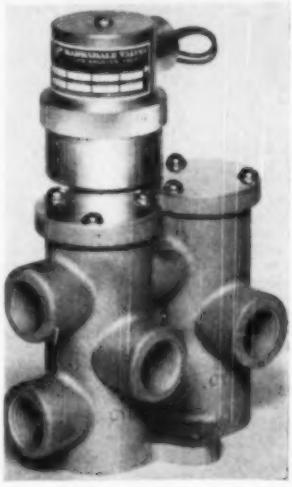
Water Conditioner

9 A combination of hot process softener and zeolite softener is employed in Cochrane Corporation's new hot process zeolite water conditioner. The zeolite softener is used as a second stage following the first stage in which lime is the single reagent. The first stage precipitates the bicarbonates and magnesium in the water supply leaving the remaining hardness to be removed by the zeolite softener, utilizing salt as a regenerant. Advantages claimed are saving in chemicals, saving in capital investment, lower CO_2 in the steam, less floor space and head room required, less operating attention, better control of phosphate excess in the boiler, lower alkalinity and only one chemical needed in the hot process.

Steam Hook-Ups

8 Sarco Company, Inc. announces the sixth enlarged edition of "Sarco Steam Hook-Ups," for steam traps, air vents, and industrial temperature controls.

Solenoid Valves



10 Crescent Valve Company's four-way solenoid valves are available for control of air, water, and light oil up to 150 psi. in pipe sizes of ¼, ⅜, ½ and ¾ inches. The solenoids are of special design to withstand continuous operation of up to 600 cycles a minute. Barksdale Valves Company is representative for Crescent valves.

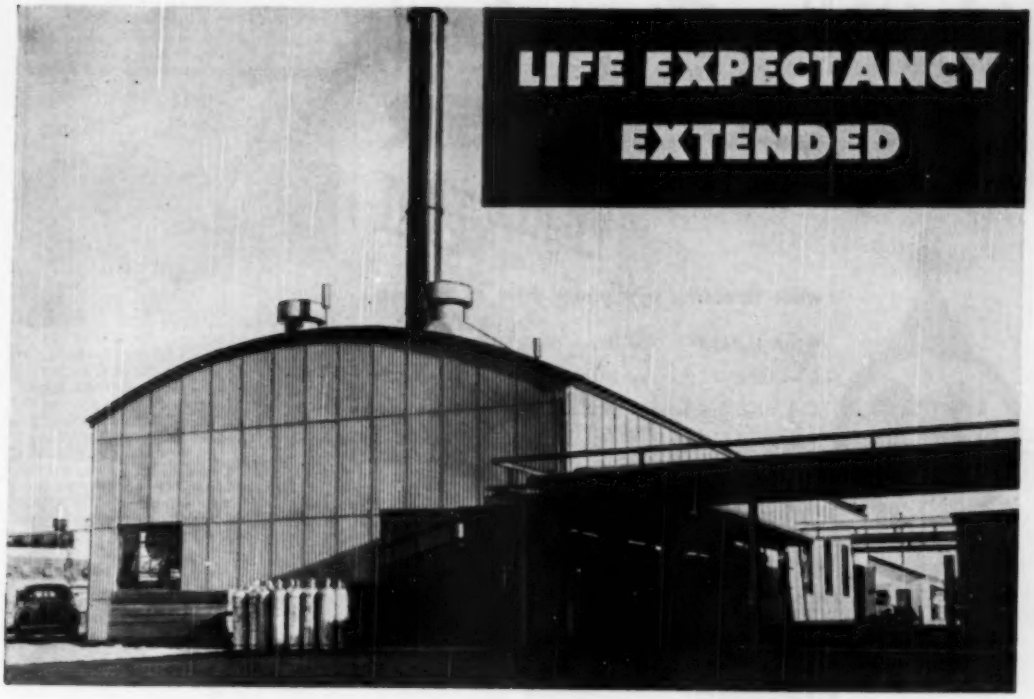
Pressure Storage Tank

11 A revolutionary new type of pressure storage tank with tank shell having double curvature and shaped like a drop of water on a flat

Need More Data?

For additional information on New Equipment items or literature mentioned in this section, use the coupon on reverse side.

Prompt action is suggested so that data will be readily available.



by K&M "Century"® ASBESTOS CORRUGATED

Compressor Room of the Birds Eye-Snider Plant at Walla Walla, Washington, is sided with K&M "Century" Asbestos Corrugated Sheets.

The sturdy "clean build" of these compressor plant walls is one sign they'll live long. They're K&M "Century" Asbestos Corrugated, the material you see on more and more industrial and commercial buildings whose owners have made sure of lasting good looks and economy.

K&M Corrugated saves from the start by simplifying and speeding erection. Cutting, drilling, fitting and anchoring are easily done, with every assurance of trim, durable enclosure. What's more, K&M Asbestos Corrugated Sheets—*stay put*. They don't give in to weather effects and fire hazard, nor to rust, rot, rodents and termites. Thus long-term freedom from maintenance goes right along with the initial economy of using K&M "Century" Asbestos Corrugated for siding and for roofs, too.

Whatever your building plans, see how much this adaptable modern material can save you. Write us for full data and the name of your nearest K&M Distributor.

Even scaffolds and extra labor are eliminated when "TOP-SIDE"* fasteners are used. They are made for use with steel members of any type, on sides and roofs.
* H. & B. Enterprise Corp.

Nature made Asbestos... Keasbey & Mattison has made it serve mankind since 1873

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NOW New Streamlined RIDGID 65R

Die Stock that WON'T JAM

while threading with power drive or by hand

New *JAM-PROOF* drive plate automatically kicks out driving ratchet pawl when standard length thread is cut.... You don't have to watch it—lead screw can't jam on workholder.

Right Here is the simple foolproof mechanism that makes 65R automatically *JAM-PROOF*.

You can convert your present 65R to new JAM-PROOF type—buy new drive plate, put in place of old plate.

All other RIDGID 65R features remain the same

Perfect threads on 1" to 2" pipe with 1 set of high-speed steel dies—sets to pipe size in 10 seconds—mistake-proof self-centering workholder sets instantly—and now it's *JAM-PROOF*.

Buy new JAM-PROOF RIDGID 65R at your supply house

RIDGID

WORK-SAVER PIPE TOOLS

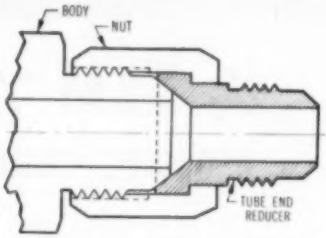
THE RIDGE TOOL CO. • ELYRIA, OHIO

New Equipment

(For additional information or literature check item numbers on mailing coupon, page 185.)

surface is available in rated capacities from 7000 to 180,000 barrels. Invented by A. Caquot, the tanks are to be manufactured by Marine Service Company, an affiliate of Vapor Recovery Systems Company. When the standard design tank is being filled, it is automatically maintained at 2½ psig. until the 40 percent rated capacity level is reached, after which it is automatically maintained at 5 psig. When emptying, it automatically reduces pressure to 2½ psig. at the 40 percent rated capacity level. Vacuum relief is at 2 ounces. Tank has no internal structures.

Tube End Reducer



12 A new tube end reducer for use with triple-lock fittings to step down to smaller tube sizes has been announcde by The Parker Appliance Company. Attached with the standard nut to the fitting tube end, the reducer provides a flared nose for the smaller tube size, and threads for the smaller nut. Made in steel, the reducer is available in ⅛, ½, and ¾ to ¼ inches or to ⅜-inch tube; ¾ to ½ and 1 to ¾-inch tube. Similarly, a brass tube end reducer, in the same sizes, is available for use with the company's line of triple brass fittings used with copper tubing.

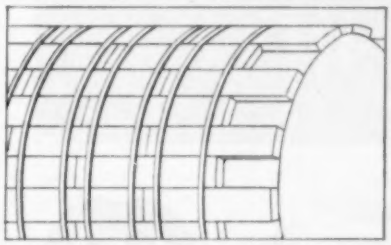
Metal Parts Inspection

13 The Turbodyne Corporation has developed a metal inspection process known as Dy-Chek which indicates the presence of cracks or other flaws too small to be seen with a magnifying glass. To be marketed by Dy-Chek Company, a division of Northrop Aircraft, Inc., the process requires no royalty or licensing fee. It can be applied by brushing, spraying or dipping, and can be used on any kind of metal. Red dye penetrant is applied to the surface of the suspected part, as those

What's wrong with this picture?

Applying 85% Magnesia Block to an outdoor tank the way these men are doing it may lead to future trouble. They're banding the insulation on in regular courses instead of staggering the blocks. This will not cause appreciable heat loss, but it will focus the effects of expansion and contraction on definite circumferential lines. Eventually the weatherproof finish will crack all the way around the tank along the line where the ends of the insulation blocks butt together.

The way to guard against this failure is simply to stagger the insulation block for block, as shown in the small drawing at the bottom of page. These interlocking courses distribute the strain of expansion and contraction evenly among all the joints, reducing the danger of breaks in the weatherproof finish.



The correct way to line up insulating block is common knowledge with experienced insulation mechanics. They don't make the kind of mistakes that will shorten the life of the work and lessen its efficiency. That's one reason why it pays to have your heat insulation done by a contracting organization like Armstrong, that employs well-trained men to work under experienced foremen and superintendents.

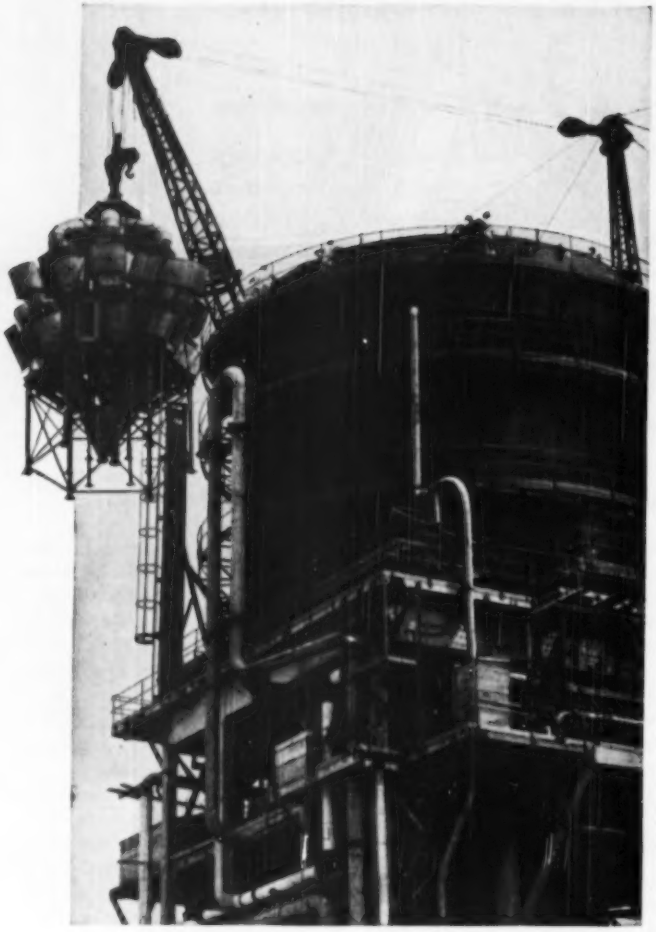
The next time you need any heat insulation work done, why not call in this experienced contractor? Just phone the Armstrong office nearest you or write direct to Armstrong Cork Company, 7507 Maple Avenue, Lancaster, Pennsylvania.

ARMSTRONG'S INDUSTRIAL INSULATIONS

MATERIALS - INSTALLATION

FOR ALL TEMPERATURES FROM 300°F. BELOW ZERO TO 2300°F.

BUELL 'GOES TO THE TOP'
in catalyst recovery



In fluid or thermofor catalytic cracking Buell recovery systems have demonstrated continuous high-efficiency performance in all the major refineries. Design information is available on the latest multi-stage collectors. Buell Engineering Company, 70 Pine Street, Suite 5070, New York 5, N. Y.

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DUST COLLECTION

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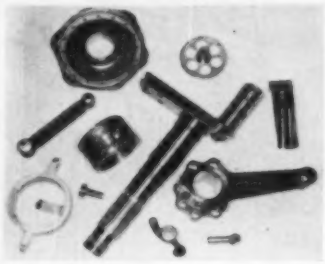
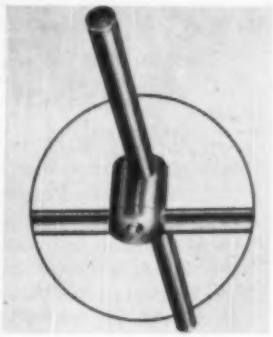


shown herewith, and allowed to stand for five minutes. It is then wiped off with a special surface cleaner and dye remover, and a white "developer" solution is applied. The red dye, possessing extremely high capillary action, is drawn from the surface openings or fissure by the developer causing the cracks to "bleed" in telltale scarlet lines against a white background.

Stationary Clamp

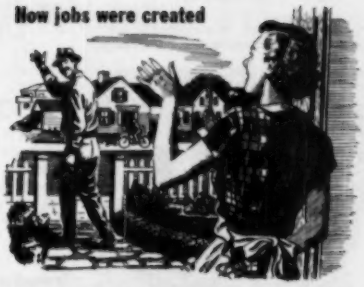


14 To reduce the cost in the construction of laboratory support frames, Emil Greiner Company offers a stationary clamp for attaching two rods at right angles. Clamp is made of a high melting aluminum alloy which will not disintegrate in Bunsen burner flame. With this clamp support frames may be constructed at 20 percent or more reduction in cost, according to the firm. Also manufactured for other sections of frame construction are the universal clamp which permits complete versatility including multiple rod attachment at any two dimensional angles, a swivel attachment to give three dimensional angle and a special attachment for wall and floor mounting and couplings.

Pump

15 Petroleum products and light or viscous fluids in volumes to 85 gpm. against pressures up to 150 psi. as required for rotary and steam atomizing oil burners, oil transfer, lubrication, and hydraulic systems can be pumped by De Laval Steam Turbine Company's IMO series A313A pump. The pump's three working parts are a power rotor and a pair of sealing or

How jobs were created



How hundreds of businesses were helped

How a new source of oil was tapped

The story behind deepwater oil

A few years ago, a test well proved there is oil under the great Continental Shelf that extends out into the Gulf of Mexico, and although the well did not produce much, it started one of the most unusual—and expensive—drilling programs in history.

So far, in the search for underwater oil, seven drilling platforms have been built, similar to the one above, as far as 10 miles offshore and in water as much as 65 feet deep. They are set on tubular steel pilings driven 250 feet through the ocean's bottom, for they must be strong enough to withstand Gulf hurricanes.

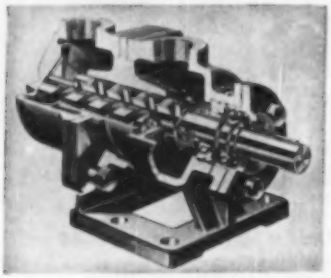
The story behind this operation is the story of risk... and of determination to do everything possible to find oil for the growing needs of motorists, farms and industries. Each underwater field costs millions of dollars more than any of equal size drilled on land, and although oil has been found, not enough has been produced yet to repay more than a small fraction of the costs.

Meanwhile, the money being risked is creating many jobs, spreading to hundreds of large and small businesses . . . and helping to keep our economy free, competitive and strong.

STANDARD OIL COMPANY
OF CALIFORNIA
plans ahead to serve you better

New Equipment

(For additional information or literature check item numbers on mailing coupon, page 185.)



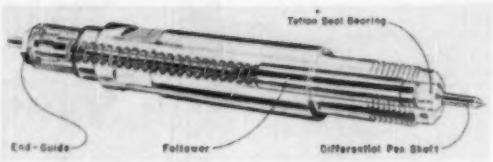
idler rotors which mesh with the power rotor in such a manner that liquid is conveyed continuously from inlet to outlet. All other parts are interchangeable. Mountable in any position, the pump's suction can be located at top, bottom, horizontal left or horizontal right.

Insulation Protection

16 Insulation protection, trade-named Overkote, and marketed by Aber Company, Inc., is a material compounded for use as a final weatherproofing and protective coating on insulation used on chillers, storage tanks, ells, valves, and various vessels utilized in the chemical and refinery fields. It is said to be adaptable whether installations are hot or cold and to be readily trowelable, furnishing a tough, long-lasting coat when dry.

Stuffing Box

17 An orifice meter stuffing box, announced by the Pittsburgh Equitable Meter Division, Rockwell Manufacturing Company, "has been proved leakproof at differentials up to 4000 psi." It allows free pen-shaft rotation at less than 9.7 inch-grams torque and requires no lubricant. The heart of the box is a combination packing and



bearing machined from Teflon Body and component parts are made of stainless steel.

Treading Safety

18 Dyna-Grip, offered by The Merchants Chemical Company, is a formulation of selected abrasives suspended in a solution of blended thermoplastic resins. When applied by brush to damp or dry surfaces of wood, concrete or metal (except galvanized iron), Dyna-Grip dries rapidly, forming a tough, permanent, non-slip treading surface. After application, surfaces are said to be unaffected by temperature changes, non-conductors of electricity and resistant to acids, alkalies, gasoline, oil, grease, and salt water. Standard colors of black, gray, and white are available.

Thermocouples

19 Thermocouples, having speed responses nine times that of previous models, have been developed by Minneapolis-Honeywell Regulator Company. Three major improvements include reduction of the mass of the hot junction in the 8-, 14-, and 20-gauge types; and shaping of the thermocouple wire to form a loop close to the hot junction. The insulator is faced about one inch from the welded tip, reducing conduction from the cold end. The dimensions of the loop permit it to fit tightly inside a well, furnishing metal-to-metal contact, eliminating dead air space.

Duplex Tubing

20 For conditions where single walled tubing cannot withstand simultaneous attack from two entirely different types of corrosive media, Bridgeport Brass Company has developed duplex tubing. The tubing is made up of two different metals or alloys inside and outside, each designed to withstand the particular corrosive medium it comes in contact with. Combinations include admiralty, aluminum brass, copper, cupro nickel, aluminum bronze, silicon bronze, combined with steel, stain-

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There is a PUMP by Aurora for every pump job.
TYPE-OD
Aurora Horizontally Split-Case, Double Suction, Single Stage Centrifugal Pump.
For general water supply for municipalities, industries, office buildings, institutions—also—for handling liquids, chemical solutions, oils etc., in a wide variety of industries. Write for Bulletin 105-M for further details.
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Asarco Sheet Lead ... All commercial weights and sizes. Chemical ... Tellurium Chemical ... Antimonial.

Asarco Lead Pipe ... All commercial sizes. Special sizes on request. Chemical ... Tellurium Chemical ... Antimonial.

Asarco Lead and Lead Lined Valves ... Split Type "Y" and "Angle", Standard "Y", Gate, Check, Hard Lead "Y", Plug and Seat.

Asarco Lead Fittings ... Elbows, Crosses, Tees, "Y's", (with plain ends, with flanges on, or for flanging in the field). Chemical and Antimonial.

Asarco Lead Wool ... 3/8" rope in 50 lb. waterproof bags.

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See Federated also for Lead Lined Pipe Lead Lined Fittings, Lead Lined Flanges

Federated Metals Division
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Use Du Pont Services to...

Save Time... Save Trouble... Save Money in Making Better Gasoline

TEL USE—The Du Pont Representative provides useful services on all problems related to the use of Tetraethyl Lead Compounds and other additives. He can be called upon for advice on efficient utilization of TEL Compounds or to supervise TEL blending plant maintenance and repair work and to advise on tank entries.

PLANNING—Whether you are building a new blending plant, selecting a site, or want to provide for future expansion of your present blending facilities, the Du Pont Representative will work with you. Through him you can obtain standard or special plans and specifications as well as actual on-the-spot assistance.

EMERGENCY AID—Du Pont Representatives are always available to assist in taking care of special or emergency problems such as those that might be caused by a damaged shipment of TEL compounds, a leaking valve, a ruptured tank or any problem of this nature.

Assistance in TEL handling starts with blending plant design.

Operators are instructed in proper unloading procedures.

DU PONT
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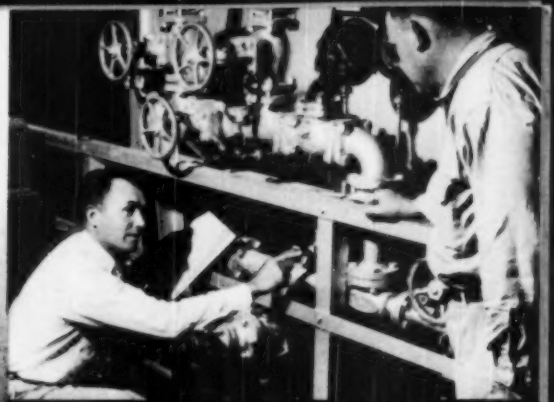
BETTER THINGS FOR BETTER LIVING
...Through Chemistry

USE DU PONT TETRAETHYL LEAD COMPOUNDS

Results of Field Laboratory investigations check a refiner's own findings as well as having many other uses.



Quarterly inspections of blending plants are only one of the services insuring peak operating efficiency at all times.

Du Pont Services Meet Many Blending Problems

Representatives are always available for assistance when repair or maintenance is required.

Blending plant repair parts and complete safety equipment are maintained in each district for quick use.

Du Pont Representatives provide those technical, safety, and medical services that directly contribute to blending plant efficiency and to refining economies. This is part of a planned Du Pont program designed to aid the refiner in making better gasolines . . . more economically.

DID YOU KNOW

That Du Pont neoprene packings make possible the efficient testing of extremely deep wells. Neoprene, because of its abrasion resistance, heat resistance and imperviousness to attack by oils is used in many oil field and refinery operations.

MAKE DU PONT THE SOURCE FOR ALL OF YOUR GASOLINE ADDITIVES ▶ **TETRAETHYL LEAD COMPOUNDS** *(Motor Mix—Aviation Mix)* **ANTIOXIDANTS • METAL DEACTIVATOR • DYES**

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PETROLEUM CHEMICALS DIVISION
Wilmington 98, Delaware

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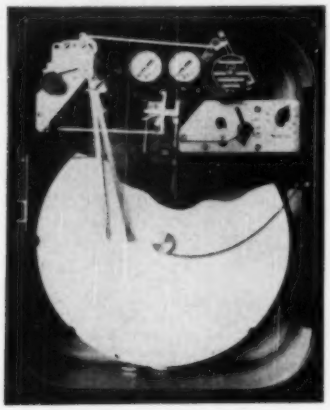
District Offices: New York, N. Y.; Chicago, Ill.; Tulsa, Okla.; Houston, Texas; Los Angeles, Calif.

District Laboratories: Wilmington, Del.; Chicago, Ill.; Tulsa, Okla.; Houston, Texas; El Monte, Calif.

A-72

less, aluminum, monel, nickel, lead, tin either inside or outside. Bulletin 1950 contains methods of installation with the object of preventing galvanic corrosion.

Air Operated Controllers



21 Sapphire jewels are incorporated in nozzle and restriction of Penn Industrial Instrument Corporation's new air operated controllers to prevent wear due to dirt, water, or oil in the air. The nozzle is fixed with no adjustment possible. Restriction cleaning lever, accessible from the front, is provided to permit cleaning of the restriction while the controller is in service. Controllers can be supplied with on-off, proportional control, automatic reset, and derivative action (sometimes known as rate response).

Oil Base Removers

22 Booklet of Oakite Products, Inc., presents descriptions as follow: the hot-flow-on method, where surfaces are flooded with hot solutions of stripping compound to remove paint from large areas or parts too big for immersion stripping; the cold-spray method of employing cold solutions to strip paint from large parts where equipment or facilities are limited; the steam gun method, where paint is blasted off surfaces by the rapid, combined action of steam and stripping compound; and the tank immersion method for stripping of rejected parts in mass production operations to prepare them for resurfacing. Also discussed are preparation before painting and anti-rust protection of stripped rejects awaiting repainting.

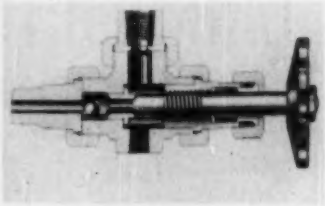
Lime Scale Prevention

23 Prevention of lime scale deposition by "threshold treatment" of the water with Calgon is described in a new folder of Calgon, Inc. Calgon, a vitreous sodium phosphate, is dissolved and the solution is added continuously to the water, effective concentrations ranging from about 1 to 10 parts Calgon per million of water. Typical applications include prevention of lime scale deposition in boiler feed water lines, water heating, recirculating cooling systems, multiple-effect evaporators, and after-precipitation following lime-soda softening.

New Equipment

(For additional information or literature check item numbers on mailing coupon, page 185.)

Gauge Valves



24 Double union gauge valves of Jerguson Gage & Valve Company, with union connection to both the gauge and the tank or vessel, can be turned in any desired angle or removed without removing the valves or draining the liquid from the vessel. Features of the four types, available include plain or quick closing, stainless steel trim, and interchangeable unions, nuts and tailpieces. All are available with tailpieces ½ or ¾-inch male, or ½-inch female. Three have regrindable seats. Literature available.

Centrifuge

25 A rheostat control provides speed control from 1800 to the maximum 5000 rmp. in unbroken sequence in Precision Scientific Company's new centrifuge. Developing 1/20-hp., the series wound motor operates on standard

Pump Packing Troubles

may mean costly shutdowns. Packing troubles ALWAYS mean higher operating costs. Have you tried Centrifugal Pumps which require NO packing? Most satisfactory for pumping acid and other corrosive liquids.

Descriptive Bulletin on Request

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You can rely on the careful attention and skilled workmanship of SUPERIOR. For the entire industry we finish jobs that meet rigid code standards and customer specifications. As a team, SUPERIOR manufactures your job—as planned and specified.

Absorber built for a West Texas repressuring plant.

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FRACTIONATING TOWERS
RETUBING OF HEAT EXCHANGERS

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CERTIFIED BY NATIONAL BOARD

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AMARILLO, TEXAS

? HAVING TROUBLE PUMPING HEAVY OILS?
CONCERNED ABOUT LOSSES RESULTING FROM VOLUME SHRINKAGE AT LOW OIL DELIVERY TEMPERATURES? ...THEN INSTALL

Paracoil

TANK SUCTION HEATERS

TO SOLVE YOUR PROBLEMS

TANK SUCTION HEATER INSTALLATION

The shell is open at the inside end. The oil moves across the heating tubes as it passes through the shell to the suction connection outside the tank.

In Bulk Oil Terminals and Refineries the world over Paracoil Tank Suction Oil Heaters are licking the problem of economically preheating heavy viscous oils to permit their withdrawal from storage tanks. They are also preheating the lighter grades of fuel oils to their proper delivery temperatures to avoid the costly volume losses incurred when such oils are sold at low temperatures.

WITH PARACOIL TANK SUCTION OIL HEATERS

- **You Heat Only The Oil That Is Being Withdrawn From The Tank.** (Thus radiation losses resulting from heating entire tank contents are eliminated.)
- **Overall Steam Consumption And Heating Costs Are Held To A Minimum.**
- **Heater Tube Bundle Can Be Withdrawn For Inspection And Cleaning.** Breaking of oil suction line not necessary.
- **All Piping Connections And Gaskets Are Outside The Tank.**
- **U-Tube Design Permits Free Expansion And Contraction Of Tube Bundle.** Either high or low pressure steam can be used as the heating medium.

SPEED UP DELIVERIES AND CUT OIL VOLUME LOSSES WITH PARACOIL TANK SUCTION HEATERS

Prompt Shipments!
Our extensive stocks of tubing and pipe enable us to make quick deliveries to meet your immediate requirements.
Write for Descriptive Literature

In addition to the Paracoil Tank Suction Heaters, we also design and fabricate Line Type Discharge Heaters of any capacity. Illustrated is a Paracoil Straight Tube Type Fuel Oil Heater for bulk station service—capacity 2,000 gallons per minute, No. 6 oil, 100°F to 160°F, steam at 15 psig. Weight 12 tons.

DAVIS ENGINEERING CORPORATION

1060 East Grand Street, ELIZABETH 4, NEW JERSEY
30 Rockefeller Plaza, NEW YORK 20, N. Y.

New Equipment

(For additional information or literature check item numbers on mailing coupon, page 185.)

115 volts a.c. to deliver 5000 rpm.—up to 20 percent high speeds on d.c. A reference dial permits duplication of selected speeds. Also incorporated is a friction leather brake. The six-tube head, which is totally enclosed with each tube in a separate compartment, is finished in neutragreen. Hammerloid, an acid alkalie and temperature resistant enamel.

Welding Cable

26 A new type welding cable for both electrode and ground, the Lind-conductor cable of The Lincoln Electric Company, has an outer cover of neoprene with a paper separator of 2½ mil thickness between the outer cover and the copper stranding. Cable is available in sizes 4/0, 3/0, 2/0, 0, #1, #2, #4 and #6. The copper stranding is a three system rope lay which incorporates a new twisting method.

Processing Unit

27 The Parkersburg Rig and Reel Company announces a Hyreco processing unit, a complete and unitized high-pressure gas well hook up. The unit, assembled on a skid base, includes a water knock-out, a special high-recovery separator, a second-stage flash chamber (when required), and pre-fabricated piping. It was designed to operate under conditions which provide for the condensation and recovery of 10 to 25 percent and more additional liquid hydrocarbons per cubic foot of gas flowed than can be obtained by conventional heater-separator installation. Bulletin HR-550.

Hard-Facing

28 "Haynes Alloys—Hard-Facing Manual" of Haynes Stellite Division, Union Carbide and Carbon Corporation, describes hard facing of metal parts as to selection of the right alloy; which welding process to use; and instructions for applying the various rods by both the oxy-acetylene and metallic-arc welding processes. Properties and available sizes of 12 Haynes hard-facing materials is also discussed.

Explosive Gas Detector

29 A portable instrument for detecting explosive gases called the "probetector" and manufactured by Atlas Exploration Company has an instrument dial calibrated for the lower explosive limit of methane gas (a 100

New Equipment

(For additional information or literature check item numbers on mailing coupon, page 185.)

reading meaning an explosive mixture). Measuring 3¼ by 4¼ by 8 inches, the instrument, including probe, weighs less than 8 pounds. The detection element is within the probe which, it is claimed, may be immersed in gasoline, water, or other fluids without harmful effect. A storage battery provides power.

Eyewear Selector

30 To aid industrial safety directors in choosing the proper safety glasses for 69 specific jobs, Bausch & Lomb Optical Company has produced a compact safety eyewear selector. Job classification numbers refer users to a sliding selection table that lists such occupations as acetylene welders, drillers, plater, and riveters. The various safety frames applicable for each task are numbered and illustrated for identification.

Outdoor Lights

31 A new line of all-weather floodlights and spotlights made of cast silicon aluminum, has been announced by Magni-Lite, Inc. Approved by Underwriters Laboratories, they feature complete lamp protection, air cooled operation, and 360 degree utility. Standard base 75- and 150-watt PARS lamps as well as the R 40 (200- and 300-watt lamps may be useed.

Fire Extinguisher

32 For Class "B" and "C" fires, and Class A fires in closed storage vaults, American-LaFrance-Foamite Corporation offers a new carbon dioxide fire extinguishing system, adaptable for the fire protection of Diesel locomotives. It is said to automatically sound warning when fire hits, stop motors, close windows, shut off fans, close doors, and put out fire.

Portable Diesel

33 A new type of diesel engine, portable but not automotive, has been announced by Ingersoll-Rand Company, in a horsepower range of 195-375 at 900 to 1000 rpm. The engine is a four-cycle, 7-inch bore, 8½-inch stroke,

MURRAY
TYPE S
VARIABLE SPEED
TURBINE

Murray Type S Steam Turbines are well suited to a variety of jobs including those drives requiring variable speed. These turbines may be constructed with hydraulic type variable speed governors and complete pressure lubrication system including reservoir, filter, cooler, oil pressure gauges and thermometers. Turbines so equipped are not only suitable for variable speed operation but for higher operating speeds as well. These features make the Type S variable speed turbine an ideal drive for high speed centrifugal compressors and blowers.

Pictured above is such a machine designed to deliver 400 HP at 7400 RPM. This machine is arranged for speed adjustment by means of hand control or by automatic control. The turbine is also equipped with a vibrating type speed indicator and a remote control tripout device. Note that the construction provides an oil tank of generous oil capacity. The combined base and tank arrangement may be extended for mounting the driven machine if desired.

Write today for full details.

MURRAY IRON WORKS COMPANY

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Builders of Steam Power Equipment for Three Quarters of a Century

Manual GAUGING is Expensive Business

In these advanced times when methods of measurement have been developed to hitherto undreamed precision and accuracy, and many new and effective mechanisms are available for the transmission and recording of forces and effects, it seems natural that attention should be directed toward the eventual elimination of manual gauging, particularly in those operations in which contractual stipulation is not a bar to the use of automatic and mechanical devices.

It is expensive because, for instance in pipe line or royalty gauging, each gauger must be provided not only with all the instruments and accessories that his work demands, but also with the means to transport them and himself from lease to lease and tank to tank. Besides that he can only gauge a limited number of tanks during his working hours, and if he is in a busy district must be displaced by relief men through the other tours.

—*John A. Sleeth, Chief Gauger Union Oil Company of California in the March 1950 issue of* PETROLEUM ENGINEER, *page D-50*

S. & J. Remote Reading Gauges combine the proven features of S. & J. Automatic Tank Gauges and the Brown "ELECTRONIK," producing accurate measurements and temperature readings almost instantly, and with absolute safety. It' tomorrow's STANDARD, ready for you TODAY.

S&J

"BE NOT THE FIRST to adopt the new, or the last to lay the old aside". Those are the words of a famous jurist, commenting on the legal angles of modern equipment. Changes in the law come slowly, and changes in tank gauging are evolving in the same manner.

Those who have learned from long experience the accuracy and dependability of automatic gauges were ready for Remote Gauging when post war electronics gave them this great time saver coupled with great accuracy. S. & J. was among the first to advocate and design automatic tank gauges for all types of storage tanks. S. & J. again leads the entire field with its new electronic remote gauging and temperature reading devices.

Write for our bulletin on Remote Gauging and learn about the electronic measurements and temperature readings which are available today, and which will be the standards of tomorrow.

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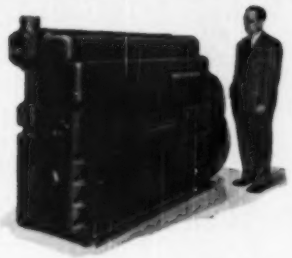
New Equipment

(For additional information or literature check item numbers on mailing coupon, page 185.)



single-acting type with weight of about 30 pounds per hp., and a fuel consumption of 0.40 pounds per hp. per hour. Normal starting is by 250-psi. air admitted to all cylinders in turn through a starting-air distributor.

Line-Operated Meter

34 Coleman Instruments, Inc., announces its new model 30—a.c. line-operated meter designed for operation at 95-130 volts, 50-60 cycles. Accuracy and reproducibility to within 0.05 pH is claimed. The instrument is characterized by its high stability and almost complete freedom from drift. It is inclosed in a black stain-and-corrosion proof plastic case equipped with a storage well for protection of the electrodes.

Warning System

35 Tellite, a warning light system, was developed by Rochester Manufacturing Company, Inc., to provide a flashing light signal to warn an engine-operator of any malfunction which might result in damage to engine parts. The remote indicating system shows low oil pressure, low oil level, low air brake pressure, excessive heat rise, generator failure or a partial set of the hand brake.

Wire Sling List

36 Cambridge Wire Cloth Company's list gives complete specifications for its entire woven wire slings series including data on over-all sling length, number of slings of a size, and fabric specifications. Slings are available in standard widths from 3 inches to 30 inches and from 36 inches to 132 inches standard lengths.

Sampling Valves

37 Features of Alloy Steel Products Company, Inc.'s, three types of corrosion-resistant valves are given in cross-sectional views of Bulletin No. 4. Also included are valve sizes, materials of construction, working pressures, and dimensions.

Internal Pipe Wrenches

38 Roddick Tool Company internal pipe wrenches are available with unconditional guarantees in newer and broader sizes of ⅛, 2½, 3, and 4-inches. The wrenches, which are ap-

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THOROUGH coverage of current technical and economic thought in the field of petroleum refining, natural gasoline and petrochemical manufacturing.

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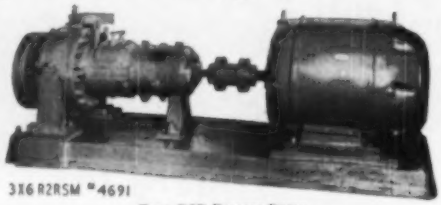
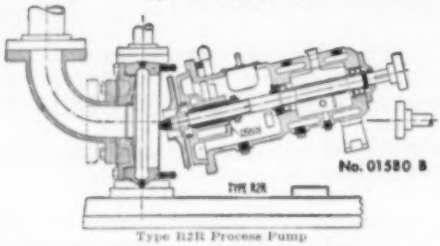
DEAN BROTHERS PUMPS INC.

Type R2R Centrifugal Process Pumps



Type R2R Process Pump



Type R2R Process Pump

DISASSEMBLY: The Type R2R process pumps can be disassembled without disconnecting the suction and discharge piping. By first removing the spacer from the spacer type coupling, and unbolting the casing from the cradle the entire cradle and complete rotating element can be removed without disturbing the suction and discharge piping.

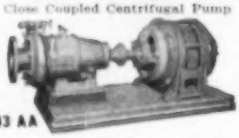
OPERATING RANGE: Type R2R, Heavy duty, process pumps are available in eighteen different sizes, enabling our engineers to furnish units specially designed and constructed for the particular work to be performed.
Capacities: 50 to 2000 Gallons per minute. Heads: Up to 400'. Speeds: 900 RPM to 4000 RPM.

BUILDERS OF OUTSTANDING PUMPS SINCE 1869

CENTRIFUGAL and RECIPROCATING PUMPS

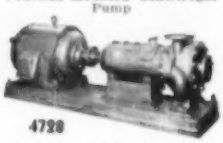
Close Coupled Centrifugal Pump

Horizontal, Single Style, Double Acting, Piston Type, Close Clearance Pump. Designed to handle volatile liquids



Pedestal Mounted Centrifugal Pump

Horizontal, Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump



Double Pedestal Bearing Centrifugal Pump

Durable Duplex Packed Piston Pattern Steam Pump, Side Pot Type

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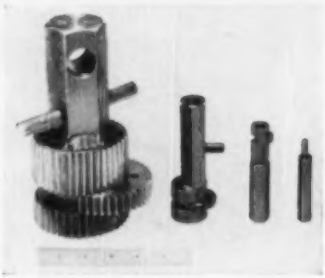


plicable to standard, extra-heavy, and double extra-heavy pipe, have one moving part. They are useful in installing and extracting fittings where conventional wrenches cannot be used.

Super-Alloy

39 A heat-resistant super-alloy, "16-25-6" is produced by The Timken Roller Bearing Company under licensing arrangement with Lebanon Steel Foundry. The carbon content is held at 0.12 maximum. The alloy is said to have high creep resistance and rupture strength at elevated temperatures runing as high as 1200 to 1500° F. Applications are for rotor wheels for turbo-superchargers, jet engine and gas turbines.

Pump Operation

40 How air pumps operate and where they are used effectively are described in Catalog 450 of Leiman Bros., Inc. Performance curves and specification tables are given on the firm's 4-wing type and 2-wing type air pumps and accessories. Leiman air pumps are of the rotary positive type, designed for producing vacuums up to 29 inches and pressures up to 25 psi. A section deals with air motors—air pumps operating in reverse with compressed air as the power source.

Heat Exchangers

41 "Karbate" brand impervious graphite shell-and-tube heat exchangers, series 240A, are described in a catalog section issued by National Carbon Division, Union Carbide and Carbon Corporation. Also included are specifications, sectional and dimension drawings. Exchangers can be operated in vertical or horizontal position with maximum recommended hydrostatic operating pressure of 75 psi., maximum steam pressure of 50 psi., and working temperature 338° F.

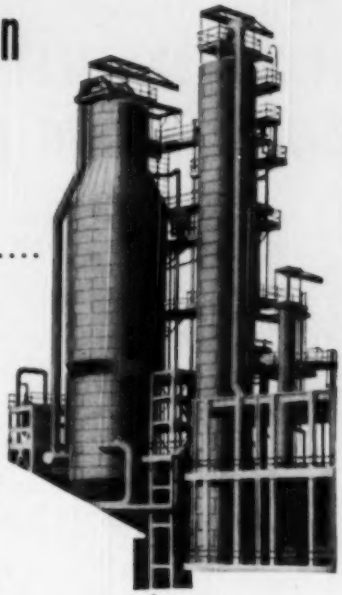
Fittings

42 Cast iron and malleable pipe fittings of Stockham Valves and Fittings, Inc., are described in Catalog 50F. A photograph and dimensional drawing plus size and weight are given for each fitting.

Electric Return Trap

43 An electrically operated trap for pumping or lifting service or for draining vacuum lines is offered in Johnson Corporation's Electrap. In-

Looking Toward Universal Operation ...While Handling Sour Crudes



PROBLEM: *Economical flashing of a lube cut at 750°F to a furfural refining stock in which sour asphalt base crudes from any source must be handled.*

DESIGN: *Flash tower for semi-automatic operation built of Lukens Stainless-Clad Steel. Design assures resistance to thermal shock. Protection from high-temperature corrosion by sulfur compounds and hydrochloric acid through inner stainless surface. Strength and rigidity through its steel backing.*

END RESULT: *Long on-stream service with continual through-puts of 20,000 bbls/day. Low maintenance. Long equipment life. Reduced manpower. Closer approach to universal operation.*

These benefits are typical of results achieved with newly developed, more efficient processing equipment. And wherever design, fabrication and materials selection must be critically coordinated, you will find the economical answer in applied *Lukenomics*. Lukenomics combines the experience of designers, engineers and equipment builders with Lukens' knowledge of materials and their application gained over 140 years as the world's leading producer of specialty steel plates, heads and steel plate shapes.

It's sound investment insurance to put Lukenomics to work on your equipment problems. There are progressive fabricators who can do this for you. Get in touch with them or write our Manager of Marketing Service, stating your problem. There's a Lukenomics team ready to go to work on it. Lukens Steel Company, 404 Lukens Building, Coatesville, Pa.

This flash tower was engineered by E. B. Badger & Sons Co. and fabricated by Sun Shipbuilding & Dry Dock Co. for Socony-Vacuum Oil Company. Made of Lukens Stainless-Clad Steel, Type 405, its design incorporates a Lukens span head measuring 20' 4" diameter, largest ever span.

LUKENS

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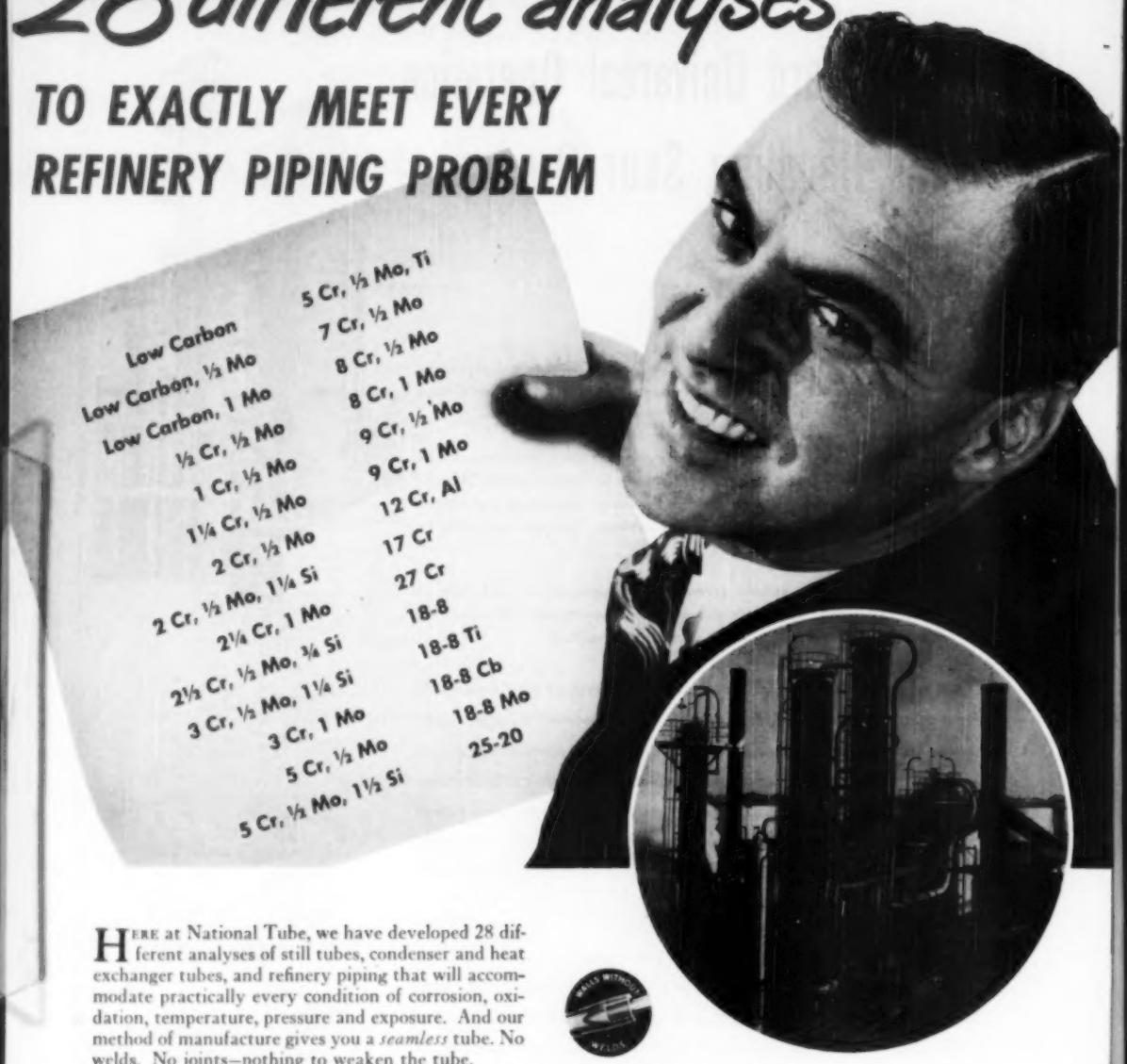
28 different analyses

TO EXACTLY MEET EVERY REFINERY PIPING PROBLEM



HERE at National Tube, we have developed 28 different analyses of still tubes, condenser and heat exchanger tubes, and refinery piping that will accommodate practically every condition of corrosion, oxidation, temperature, pressure and exposure. And our method of manufacture gives you a *seamless* tube. No welds. No joints—nothing to weaken the tube.

But remember: even with such a wide choice at your command, the selection of the proper alloy requires careful consideration. Otherwise you may end up with tubing that either does not give maximum performance or costs more than necessary.

That's why—to obtain optimum results at minimum cost—we suggest that you submit your problem to our engineers *before* you select new tubing or piping. Our huge file of successful refinery applications means that there's a good chance that we have encountered and *solved* problems just like yours before. And in case your application involves conditions that are entirely new, the wide experience of our experts will be of material assistance in finding the best solution possible.

Use this skilled background. For information, write to National Tube Company, Frick Building, Pittsburgh 19, Pennsylvania.

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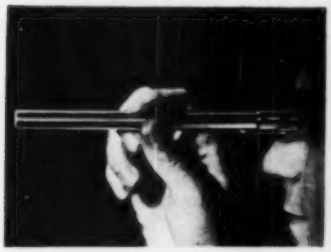
NATIONAL SEAMLESS PIPE AND TUBES

UNITED STATES STEEL

cluded in Bulletin "ET" are operation details and drawings of typical installations. Also explained is how the Electrap is being used to return condensate from high-pressure processing equipment back to boiler room at higher temperatures.

Pocket Telescope



44 A six-power fountain-pen size telescope, five inches long and weighing two ounces, has been developed by Pan-technics, Ltd. The telescope has full magnification and a field of view of 315 feet at 1000 yards. A scientifically computed optical system of six coated lenses gives full correction for spherical and color aberration. The Penscope, as it is called, affords instant, finger-tip focusing.

Moisture Eliminator

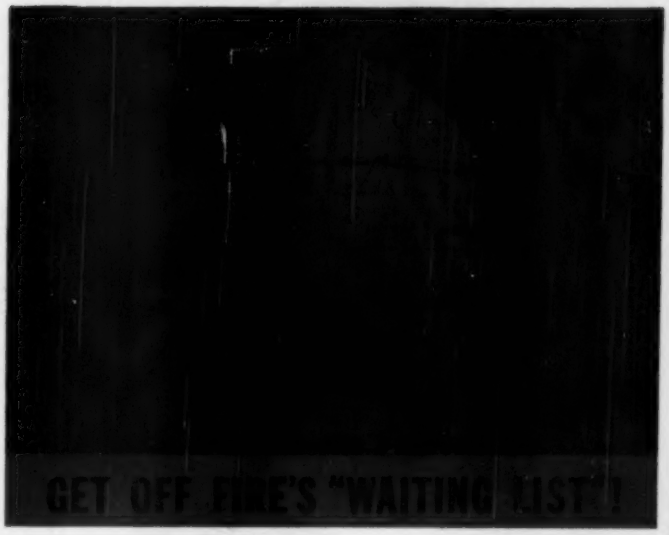
45 Drain Master, a new automatic moisture eliminator of Master Equipment Corporation, ejects moisture and oil from air brake systems, air line traps, and air compressors, operating on the build-up and relief of pressure. The ejectors are two inches high and weigh three and one-half ounces. One model is especially designed for automotive air brake systems, the other for industrial applications.

Steel Strapping

46 Types of steel strapping for banding insulation to towers, vessels, piping, and other refinery equipment are described in a bulletin of A. J. Gerrard & Company. Included are monel, stainless steel, brass, galvanized steel, copperclad, aluminum, standard steel, balata, fiber and steel, and stur-d-Strap (a laminated strap of 100 percent rag sheets). A steelbinder which ties angular and cylindrical surfaces is also explained. Other strap data deal with type coil, weight of coils, footage per pound, and seals, tools, and accessories.

Control Valve

47 A steam-jacketed flow control valve has been developed by G. D. Jenssen Company, Inc., for the control of molten sulfur at 275° F. in rotary sulfur vaporizers in the sulfite pulp industry. Immediately available in sizes of ½ and ¾ inches, it is adaptable for flow control on thermoplastic materials such as asphalt, wax, and resins, which must be handled in a molten state. The valve, which is actuated by a flanged



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Deluge Systems, Wet Pipe Systems, Dry Pipe Systems, Water Spray and Fog Systems, Rate-of-Rise Sprinkler Systems, and Carbon Dioxide Extinguisher Systems.

Blaw-Knox Fog Nozzles, actuated by rate-of-rise thermostats, don't wait for petroleum fires to get out of hand. These sensitive detectors go into action with the speed of electricity . . . sending a heavy, quenching fog to the point of danger and adjacent areas. Even with low pressure and raw water, the non-clogging fog nozzles blanket "hot spots" with a deluge of water that either extinguishes or confines flash fires to a small area.

A survey of your fire hazards to determine which system will give you the utmost protection at the least cost involves no obligation.

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18-8 Centrifugal Castings

...specified "centrifugal" because uniform, close-grained metal was wanted

These castings are sections of a special fractionating column, cast and flanged as illustrated at the right; machined and finished at the left.

Why **centrifugal** castings, you ask?

Specifications called for an exceptionally close-grained, uniform metal structure free from blowholes of any sort on the inner face. Centrifugal castings assure this superior metal structure.

Our service to industry is two fold: centrifugal castings and static castings, produced in one of the most modern and best technically controlled foundries in the country. Why not try Duraloy for your next high alloy casting requirement?

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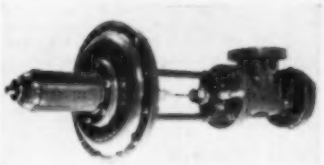


diaphragm motor in conjunction with any standard air-operated control instrument, is normally furnished spring-closing, air to open. The chrome nickel seat is removable and the chrome nickel stem is lubricated.

Thermometers

48 Liquid-filled, vapor pressure, and gas-filled thermometers of The Bristol Company are described in models for recording, indicating, controlling, and telemetering of temperatures. Included are operating principles, characteristics of operation, temperature sensitive bulbs, recording charts, and accessories. Accompanying data are photographs and reproductions of actual temperature chart records and sketches of applications.

Strainers

49 Fine screen screwed strainers of Yarnall-Waring Company are described in Bulletin S-203. Included are special features, materials, advantages, and suggestions for installation. Prices, weights, and dimensions are also given. A photograph shows how to replace the screen. Mixmum pressures and temperatures plus a perforated screen data chart are given for flanged strainers.

Solenoid Valves

50 Direct operated solenoid valves, in sizes from ½ to 3 inches, are described in Johnson Corporation's Bulletin "V." A cross-section shows construction, and drawings picture typical installations. Included are valves for normally open or normally closed service; stainless steel or Jenkins disc seats; valves with special dash-pot construction to stop water hammer; and 3-way solenoid valves. All valves are built for pressures up to 150 pounds, quick-opening and free of any pilot valve or auxiliary pistons.

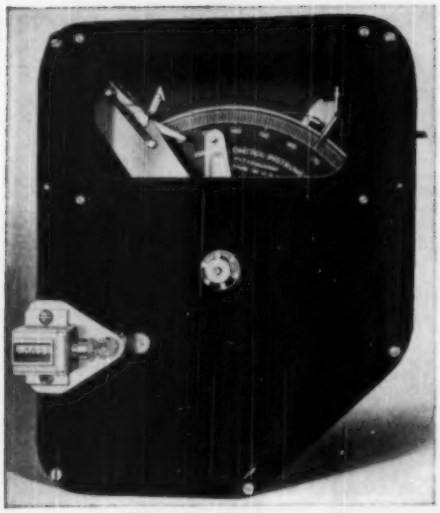
Expansion Joint

51 Design and construction of Corruflex, American District Steam Company's corrugated packless expansion joint that requires no maintenance, is explained in Bulletin No. R-35-51. Sizes, temperature and pressure ratings, dimensions, and weights are also given as are simplified selection charts.

Resistance Thermometer

52 Type 1000, resistance thermometer of W. S. Macdonald Company, Inc., has a resistance of 25 ohms at 25° C. and sensitivity of 0.1 ohms per degree centigrade. The sensing length is

Accurate integration over the entire range in HAGAN



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This wide range accuracy is due to the unique design and precision construction of the Hagan integrator.

In this integrator, a large toothed wheel is set in motion periodically. The movement at each interval is governed by the flow index pen and is proportional to the momentary rate of flow. The wheel is geared to a counter which registers the total flow through any period, by difference in the counter readings.

The Hagan Integrator differs fundamentally from others in that all associated parts rotate around a common center. As a result, angularity errors are eliminated and only one simple adjustment is required for calibration throughout the range. The large five inch integrating wheel produces the required selectivity to integrate as low as two percent (of chart) with high accuracy. With this construction, wear between toothed wheel and the pawls is eliminated. There are no clutches to wear and slip.

The instantaneous pawl action also produces high accuracy under rapidly fluctuating flow conditions.

The graduations on the large wheel and pointer facilitate checking the calibration of the integrator at any point in the range in one minute or less.

The Hagan Integrator is a self-contained unit and may be mounted conveniently in any of the various types of Ring Balance flow meters, or pneumatic receivers.

For full information on this and other features of Hagan Ring Balance meters, write to Hagan Corporation, Hagan Building, Pittsburgh 30, Penna.

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RING BALANCE FLOW AND PRESSURE INSTRUMENTS
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BOILER COMBUSTION CONTROL SYSTEMS
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Right Down The Middle With
FORGED STEEL VALVES

Orbit Forged Steel Valves are solving the processing and handling problems ordinarily associated with gasoline and LP Gas plant services.

This 40 Car LP Gas loading rack is equipped with 285 Orbit Fig. No. F2501-3, 2½", 300 lbs., 500 lbs., W.O.G., (1000 lbs. test) Carbon Steel Trimmed Valves.

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the insulation on your hot or cold vessels — for YEARS!

Specified by Leading Refineries for over 15 Years.

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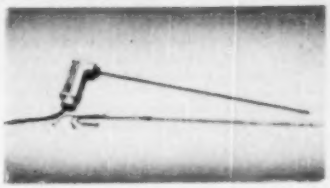


2 inches, and the over-all length is 18 inches. The sensing element is sealed in a quartz chamber whose diameter is ¼ inch. Jacketed assembly is 5/16 inches. The element is tungsten and the chamber is evacuated prior to sealing. Three leads are brought out from the element to compensate for temperature change in the leads.

Wired Television

53 A wired television installation, the "Utiliscope" of Diamond Power Specialty Corporation, consists of a camera, a small power unit, and moniter or viewing unit. It weighs 121 pounds. The viewer, shows the image on a 6¼ by 8¼ inch screen. The viewer contains a cathode ray tube with its associated circuits. The image dissector is a cold cathode camera tube guaranteed for one year. The power operating the dissector tube and sending the signals to the viewer over a three lead co-axial cable is supplied from eight ordinary vacuum tubes. The power unit has 250 watts capacity. Applications are explained in Bulletin 1025 which also discusses advantages.

Ventilation Guide

54 "Industrial Ventilation Guide," offered by Propeller Fan Manufacturers' Association, discusses types of ventilation, system pressure, recommended air changes, duct resistance chart, and calculation of resistance. Certified rating tables are provided by leading manufacturers of industrial ventilation equipment for further guidance.

Flow Meters

55 A new line of mercury manometer flow meters by Fischer & Porter Company requires no pressure-tight bearings or stuffing boxes. They use a magnetic clutch or the impedance bridge electric transmitter which has three times the power of previous similar devices. The line is available with close-coupled magnetic clutch, with or without pneumatic transmission to a remote location; electric impedance bridge transmitter when it is desired to transmit to a distant exhibiting instrument; and automatic control of the ratio of flow rate of two fluids. Furnished with 35, 50, 100, 200, and 400-inch water column equivalent range tubes, the meters withstand 1500 psig. in cast steel construction.

Heat Exchanger

56 Expanding its redesigned line of heat exchangers, Young Radiator Company announces its new type "R," removable tube bundle, shell and tube heat exchangers of corrosion-resistant Admiralty metal tubing. In larger tube sizes ⅜ and ⅝-inch o.d., the

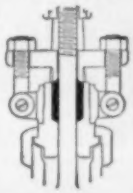
TEFLON Gaskets & Packing Defy Chemical Attack

Stay in Service Months Where Others Fail in Hours

Last November we sent one manufacturer a Teflon-Chemiseal packing for a pump handling hypochlorites. This packing is still going strong—on a job where all other packings failed within 5 hours. We have hundreds of similar reports about the service given by Teflon-Chemiseal gaskets and packings. Here's why—

Teflon is *chemically inert*, cannot be attacked by any industrial acid, solvent, or alkali, will *not contaminate* any material conveyed in piping. Teflon also possesses unique natural slipperiness. Teflon gaskets never stick, are never defaced when joints are opened, but can be used over and over. Teflon *packings* never "seize" a valve. They permit free spindle operation at all times.

Investigate Teflon-Chemiseal gaskets and packing. They can save you hundreds of dollars and countless production delays.

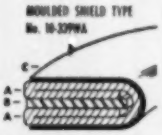


CHEMISEAL 810W SOLID TEFLON CUP-AND-CONE PACKING FOR VALVES

One of many Teflon-Chemiseal packings available. Chemical-proof, require light gland pressure, will not freeze a valve no matter how long unoperated.

TEFLON-JACKETED OR SOLID TEFLON GASKETS

Stocked in many standard sizes. Chemical-proof, non-contaminating, won't stick. (Many jacket and insert combinations. Special shapes also.)



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line consists of both single and two-pass models in a wide range of capacities.

Pressure Bolts

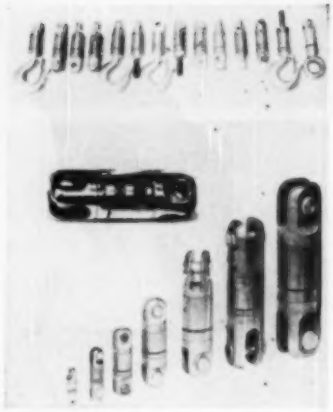
57 The safety release pressure bolt manufactured by Thomas C. Wilson, Inc., is actuated by the pressure within the vessel. A hole through the bolt body conducts the fluid under pressure to a piston within the bolt head and causes the handle-bar to be moved and held out of bolt turning position. When under pressure, the handle may be freely rotated without imparting turning movement to the bolt proper. When the pressure is released, the handle automatically returns to bolt-turning position and the member secured by the bolt may be safely removed.

Sieves

58 Market grade testing sieves and an "End-Shak" testing sieve shaker are described in a Newark Wire Cloth Company folder. Specifications of sieves are given according to the National Bureau of Standards, ASTM and ASA.

Swivels

59 A strengthened and more complete line of Miller swivels for eliminating wire line twist and kinking has been announced by General



Machine & Welding Works. Fifteen different types of end connections and nine swivel capacities ranging from the "AA" model rated at 250 pounds working load to the "H" model at 46,200 pounds working represent the line. Catalog available.

Metal Selection

60 Hunt-Spiller Manufacturing Corporation's metallurgical bulletin is designed to aid the user of industrial castings in the selection of proper metals and alloys. Complete physical and chemical properties, general descriptions, metallographical plates, suggested applications and other important information is included on a number of metals. Included is gun iron, a dense, close-grained iron, highly resistant to frictional wear.

Vibration Control

61 Characteristics of vibration isolation media—springs, rubber, and cork materials—are given in Bulletin G-102 of The Korfund Company, Inc. Fifty typical applications are tabulated with recommendations for proper types of vibro-isolators for highest efficiency, and with alternates. Standard mountings are described with data or loading ranges which run from 10 pounds for small isolators to 50,000 pounds per isolator for a heavy duty spring type. Specific purpose isolators for business machines, fan and motor units and other applications are also described.

Generators and Furnaces

62 Petro-Chem Development Company's Bulletin 50-1 describes operating characteristics of the radiant convection design Iso-Flow furnace. Bulletin 50-2 contains a summary of the design and operating test data on a 50,000 pound per hour Iso-Flow steam generator installation.

Vacuum Pumps

63 "Much Ado About Nothing" describes Beach-Russ Company pumps designed to supply vacuum in the range from 5 to 10 microns. Construction is of two moving parts, a rotor and its slide valve, both completely oil sealed at all times in the pump cylinder. Data on rotary vacuum pumps are contained in Bulletin 87, covering vacuum applications to 5 mm. absolute. Bulletin 84 includes high vacuum pumps for vacuum applications to 5 microns.

TULSA TYPE

BUILT Right

Versatility of design and fabrication along with sound engineering, accurate specifications and precision workmanship bring the petroleum industry a complete, efficient line of processing equipment.

Specify TULSA TYPE processing equipment . . . and you have specified the best.

Write for General Catalog

FLINT STEEL CORPORATION

TULSA, OKLAHOMA

A NEW HIGH!

in Pressure Measurement

80,000 psi

and what it means to you . . .

Heavy-Duty Helical 50 to 80,000 psi

Helical 100 to 10,000 psi

Spiral 5 to 450 psi

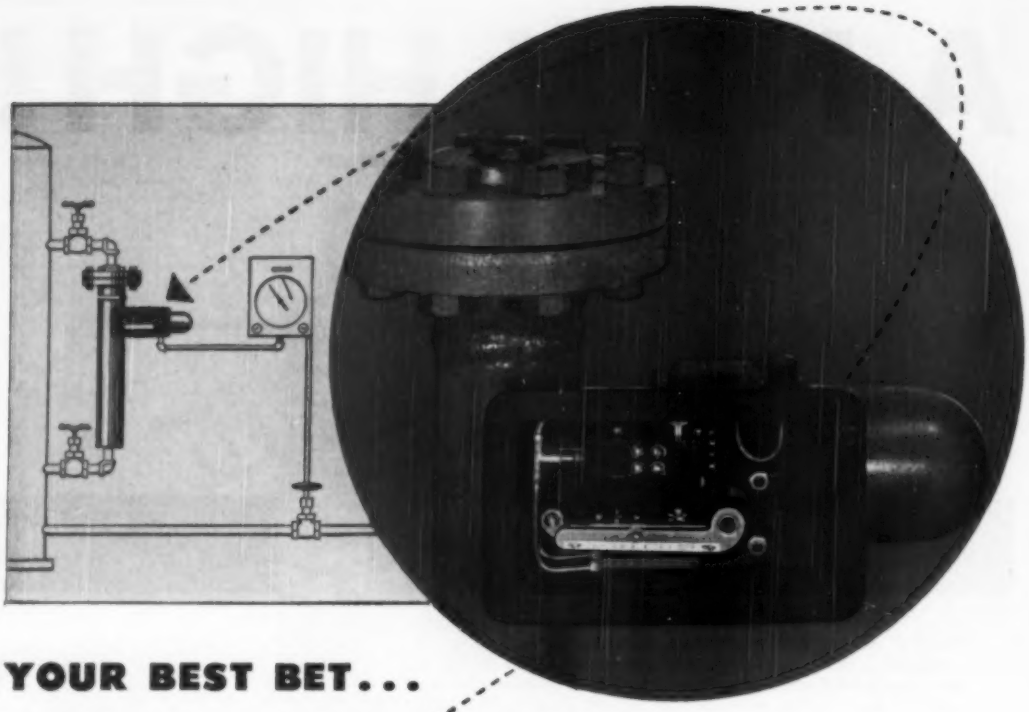
Whether or not you ever need accurate measurement of pressures in the super-range of 50,000 to 80,000 psi, this new, exclusive helical spring developed by Foxboro illustrates the advance engineering you will get in any Foxboro Pressure Instrument.

Ever since Foxboro introduced the helical pressure element with fixed center of rotation, industry has accepted the accuracy and performance of Foxboro Instruments as standards in the field. These standards may be your answer to immediate pressure problems.

Foxboro has the most complete line of pressure instruments available. You have a choice of rectangular or circular cases . . . spring elements in phosphor bronze, beryllium copper, or Type (316) Stainless Steel. For normal applications, the standard *spiral* and *helical* elements are standards of superior performance . . . rugged, fatigue-free, lastingly accurate. For the difficult, unusual jobs, the new *heavy-duty helical* offers radically new design utilizing the tough, corrosion-resistant properties of Type (316) Stainless Steel . . . particularly adapted to rapidly pulsating service from zero to full pressure . . . and to expanded ranges. Responsive and absolutely safe on pressures up to 80,000 psi. Other elements (not illustrated) include: *diaphragm*, 0-2" water to 0-5 psi; *bellows*, 0-5 psi to 0-25 psi; *absolute pressure bellows*, 0-4" mercury to 0-40 psi absolute.

This unequalled range of pressure elements, engineered to the highest standards, is your assurance of the best pressure instrument for *any* industrial application. **The Foxboro Co., 246 Neponset Avenue, Foxboro, Mass., U.S.A.**

FOXBORO REG. U. S. PAT. OFF. **PRESSURE RECORDERS**



YOUR BEST BET...

For Liquid Level Measurement In Continuous Processes...

THE HONEYWELL DISPLACEMENT-TYPE TRANSMITTER

TODAY's continuous processes demand the type of liquid level measurement best provided by this Honeywell Displacement Type Transmitter. Its outstanding features include *unusual sensitivity* (1 part in 5,000), *friction-free design* and *high speed response* (less than 5 seconds, full range).

It affords dependable measurement of many different liquids (Sp Gr 0.3 to 2.0) without changing parts . . . unaffected by ambient temperatures and vibration. Neither purge nor liquid seals are required. It is easy to clean. It is available in nine operating ranges for level measurements from 0" to 120" . . . with connections to suit all usual process vessels. It may be connected to any pneumatic receiver . . . indicator, recorder or controller . . . and operates with a full range of transmitted air pressures from 3 to 15 psi.

For more detailed information about this transmitter, call in your local Honeywell engineer . . . he is as near as your phone! MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 1907 Windrim Ave., Phila. 44, Pa. Offices in more than 80 principal cities of the United States, Canada and throughout the world.

MINNEAPOLIS **Honeywell**

VALVE PRODUCTS

Pressuregraph

64 Electro Products Labs, Inc. has developed a pressuregraph for electronic measurement and recording of dynamic and static pressures. The equipment consists of an electronic pick-up, which is connected to the region where the pressure is to be studied, an associated electronic circuit and power supply, and a cathode-ray oscilloscope on whose screen the pressure-versus-time characteristic is presented.

Blowdown System

65 The Henszey Company's folder and chart shows how to determine the proper size continuous blowdown system for an installation. The chart takes into consideration variables as impurities in feed water, desired concentration in the boiler, amount and temperature of makeup and boiler pressure. Size of the required blowdown system is read directly from the chart which shows annual fuel savings effected by blowdown heat exchangers based on an average fuel cost and boiler efficiency.

Water Clarifiers

66 Design and operation of Reactivator type of water clarifier and cold process softener are explained in Bulletin WC-103 of Graver Water Conditioning Company, a division of Graver Tank & Manufacturing Company, Inc. The principles and chemistry of cold process water treatment are also explained and various accessories shown.

Hose Ends

67 The Weatherhead Company is offering three new bulletins on its line of industrial hose and hose ends and tube fittings. Catalog H-1451 lists latest developments in reusable steel hose ends and industrial hose for hydraulic purposes, fuel and oil lines for diesel engines, and other flexible hose requirements. Catalog No. E-1457 explains Ermeto steel and stainless steel fittings which require no flaring, threading, welding, or soldering, and consists of three parts. Catalog No. F-1456 shows a complete line of brass inverted, SAE, compression, threaded sleeve type and pipe fittings which are made from extruded brass rod.

Loading Stem Valves

68 Slow-closing, hydraulically balanced features, said to eliminate valve slamming, line shock and difficult opening due to line pressure, are incorporated in a new loading stem valve offered by Granberg Corporation in sizes of 2, 2½, 3, and 4 inches. Standard 125-pound flanges are also available.

Remote Controls

69 Bulletin 20-105 of Sperry Products, Inc., describes two series of hydraulic remote controls and available accessories, including intermediate transmitter for use at secondary control stations. Features include use of a single line up to 200 feet long for connecting transmitter and receiver, balance obtained by use of opposing springs, and easy synchronization.

Clipper Seals

70 Close-up photographs in a Johns-Manville handbook show where to use clipper seals and how to install them to solve bearing protection problems. Drawings indicate how the lip and heel construction of the non-metallic oil seals can be varied. Other sections include explanations of the principle of clipper seals, their construction, advantages in application, and installation.

New Equipment

(For additional information or literature check item numbers on mailing coupon, page 188.)

Double Suction Pumps

71 Two-stage, double-suction centrifugal pumps with mechanical seal and described in Bulletin W-318-B21, Worthington Pump and

NEW LIFE
FOR OLD DRUMS

after only 6 minutes of Oakite cleaning

SEND for *free* Booklet. Packed with helpful hints on cleaning, derusting, descaling bubble towers, heat exchangers, pumps, valves, tools, etc.

That's right—used drums restored to first-rate condition—cleaned, rinsed and dried—after only 6 minutes! That's how fast specialized Oakite cleaning works.

Reconditioning barrels and drums the Oakite way has these extra advantages: Fewer rejects . . . more uniform paint stripping . . . better adhesion for new paint. Eliminates paint build-up on steam coils . . . stops clogging of drains and sewers.

Your local Oakite Technical Service Representative will gladly help *you* get better, faster drum conditioning. Call him today. Or write for free booklet. No obligation either way.

OAKITE PRODUCTS, INC., 380 Thames St., NEW YORK 6, N. Y.
Technical Service Representatives in Principal Cities of U. S. & Canada

OAKITE

PETROLEUM SERVICE DIVISION

New Equipment

(For additional information or literature check item numbers on mailing coupon, page 185.)

Machinery Corporation. The Type UZD pumps have hydraulic design with radial and axial balance achieved through proper impeller and volute design. Other features listed include construction, materials, stuffing boxes, bearings, applications, elastic seal rings, long interstage loops, bottom suction, and wearing rings.

Wallace Products

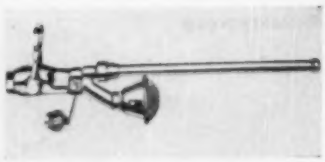
72 Products and services offered by Wallace Supplies Manufacturing Company and its subsidiaries, Wallace Tube Company Division, Alloy Tube Company Division, and Welded Truck & Specialty Company Division, are described in a new company catalog "So You Want to Use Tubing." Included are bending machines, saws, shears and cutters, wire parts, cylinder tube and fabricating services.

Lab Apparatus

73 Catalog No. 50, "Selected Laboratory Equipment" of Schaar and Company, covers current apparatus for research and routine work in industrial, educational, and institutional labs.

Foam Extension Unit

74 A new lightweight foam extension, when applied to Rockwood Sprinkler Company's SG-48 nozzle, can deliver five different kinds of discharge from only the one nozzle—



high or low velocity waterfog, solid water or foam stream, and fogfoam. The extension units are for use with nozzles on ¾, 1, 1½ and soon on 2½-inch fire hose lines. The combination will handle any type of fire in ordinary combustibles, flammable liquids or materials that can be extinguished with water alone or water mixed with foam liquid.

Close-Coupled Pump

75 Designed to meet the need for a pump where net positive suction is limited or where installation space is limited, is the new encased, close-coupled vertical centrifugal Hydro-Line pump developed by Peerless Pump Division, Food Machinery and Chemical Corporation. Bulletin B-592 contains construction features, applications, characteristics, installation and maintenance.

Temperature Indicators

76 Tempil® Corporation announces a new brochure describing its line of temperature-indicating products and listing directions for use and typical applications for Tempilstiks®, Tempilaq® and Tempil® Pellets are listed. Available temperature ratings cover the range from 113° F. to 2500° F. in closely spaced temperature intervals. Catalog No. 501 gives more details.

Pressure Paint Brush

77 A pressure-fed paint brush of Hanlon & Goodman Company has an inside brush which acts as a feeder to the outside larger brush. Four brushes are made, a 2¼-inch oval, and a 3-inch, 3½-inch and 4-inch flat.

Liquid Bromine Safety

78 "Methods and Materials for Handling Liquid Bromine," The Dow Chemical Company, covers precautions, methods and materials for handling, handling and use from glass bottles, lead-lined drums and tank cars.

Measuring Tapes

79 Stainless steel tapes by The L. S. Starrett Company are described in Bulletin 112. Related equipment includes levels, transits, and tools, plumb bobs, tape hooks, and tape wipers. Tapes offered include steel, pocket, frame, and oil gaging.

Laminated Panels

80 The Kaylo Division of Owens-Illinois Glass Company, has announced a new light-weight laminated panelboard that is particularly suitable for interior partitions and walls in refineries, natural gasoline, and petrochemical plants. Available in facings of cement-asbestos, porcelain enamel, wood veneer, aluminum, and stainless steel, these panels are claimed to have ease of installation, fire resistance, high insulating factors, permanence, and great struc-

For Lower Delivery Costs!

"NEWTYPE"

GASOLINE TRUCK HOSE STYLE R-43

Every feature of "Newtype" Truck Hose contributes to maximum service . . . *with low-cost deliveries.* Its light weight and extreme flexibility make it easy to handle. Its kinkproof, non-flattening construction permits a full, fast flow from truck to storage tank. Its tough, compact cover provides exceptional resistance to severe abrasive wear, prolonging the useable life of the hose and assuring important savings in replacement costs.

Contact Our Nearest Branch for Details and Prices

GOODALL RUBBER COMPANY

GENERAL OFFICES, MILLS and EXPORT DIVISION, TRENTON, N. J.

Branches: Philadelphia · New York · Boston · Pittsburgh · Chicago · Detroit · St. Paul · Los Angeles
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Est. 1870

KEEP EQUIPMENT ON STREAM

. . . with these Special Properties of Stainless Steels

STRENGTH . . . *at temperatures that would destroy ordinary metals . . .*

RESISTANCE TO ATTACK . . . from organic and mineral corrosive agents . . .

HIGH IMPACT VALUES to temperatures as low as −320° F.

These characteristics of austenitic chromium-nickel stainless steels help to save labor as well as time, and reduce costs by keeping equipment on stream.

Austenitic chromium-nickel stainless steels provide one of the strongest, toughest, and most economical means for extending the life of bubble towers, reactors, vapor lines and other vital equipment.

Investigate all the benefits stainless steels can give you. Leading steel companies produce austenitic stainless steels containing nickel in sheet, strip and all other commercial forms. A list of sources of supply will be furnished on request.

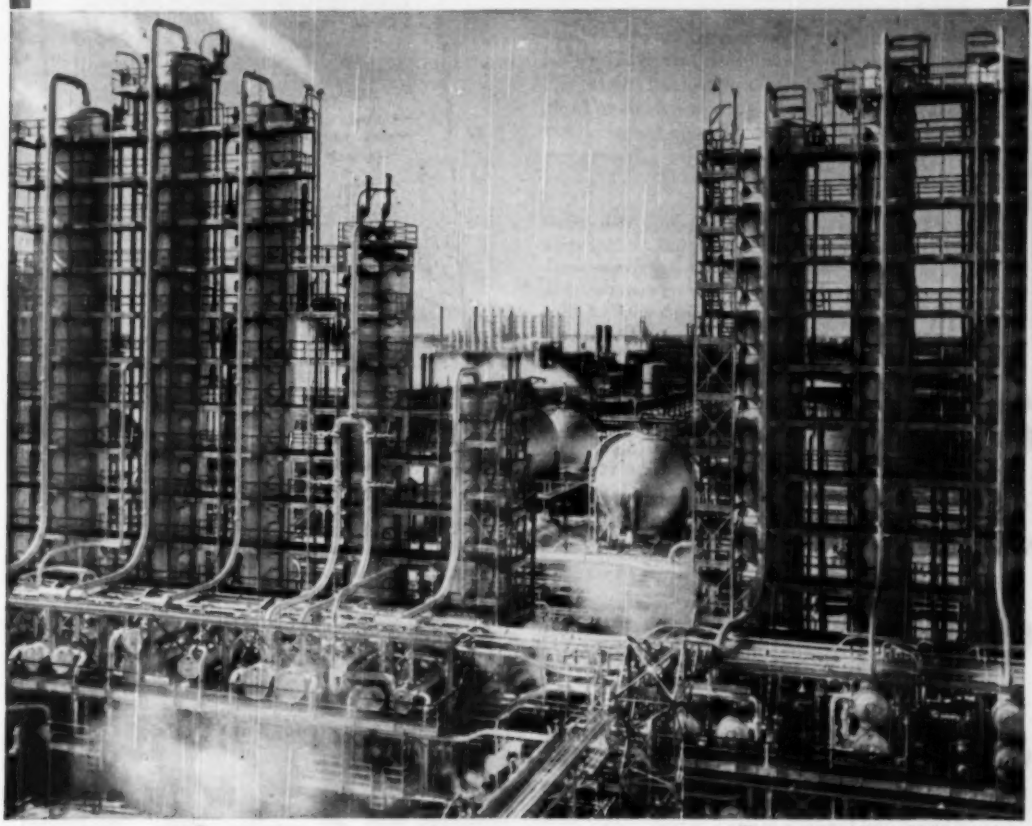


Photo courtesy of Standard Oil Co. (N. J.)

EMBLEM OF INCO SERVICE
TRADE MARK

Over the years, International Nickel has accumulated a fund of useful information on the properties, treatment, fabrication and performance of engineering alloy steels, stainless steels, cast irons, brasses, bronzes, nickel silver, cupro-nickel and other alloys containing nickel. This information is yours for the asking. Write for "List A" of available publications.

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N.Y.

THE BIG 5

pay off with ALCO AIRCOOLERS

Pioneered by one of the largest makers of heat exchangers, Alco **Aircoolers** are built to do just one thing and do it right—cool efficiently. To accomplish this, Alco engineers have built into every Alco **Aircooler** design features that give you *all* five of these major advantages:

1 ***Low Cost***—goes way beyond first cost. Alco standardized parts . . . broad heat-transfer experience . . . volume production . . . plus correctly engineered safety factors . . . insure *real* economies in installation, operation and maintenance of Alco **Aircoolers.**

2 ***Flexible Design***—You can get either the radiator core or fintube type cooler from Alco, powered by electricity, steam, gas or oil.

3 ***Efficient Performance*** – Induced draft design eliminates the chance of recycling hot air with a subsequent loss in heat transfer.

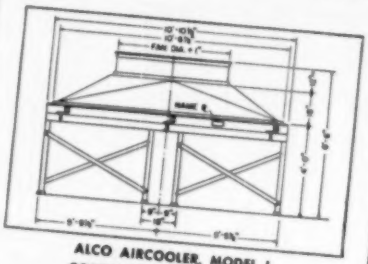
4 ***Easy Maintenance***—Fewer parts, easy accessibility and better wearing characteristics make Alco **Aircoolers** a favorite with maintenance men.

5 ***Quick Installation***—For fast field assembly, every part is marked and identified on assembly drawings so that no specialized labor is required.

Why not put the big 5 to work in your plant? Send for the free catalog on Alco **Aircoolers** *or call your nearest Alco Sales Engineer at Chicago, Cleveland, Houston, Kansas City, Los Angeles, New York or Tulsa. Plants at Dunkirk, N. Y. and Beaumont, Texas.*

ONE AIRCOOLER FROM THE ALCO LINE

Hundreds of Alco Aircoolers are in service cooling jacket-water, gas, engine-lube oils, vapors, etc.



ALCO AIRCOOLER, MODEL I
CONDENSED SPECIFICATIONS

No. radiators—Four 6-ft. nominal length.

Fans—5 or 6 ft. dia.—2, 4 or 6 blade—adjustable or fixed pitch.

Drive—Direct, Electric Motor (V-belt or Gear Drive can be furnished on request).

Surface External — 2,720 sq. ft. Style T-5 (Water Core)—2,611 sq. ft. Style T-1 (Oil Core).

Surface Internal—450 sq. ft. Style T-5—347 sq. ft. Style T-1.

Face Area—46.4 sq. ft.

ALCO

ALCO Products Division
AMERICAN LOCOMOTIVE COMPANY

In step with tomorrow—**ALCO AIRCOOLERS, Heat Exchangers, Evaporators, Feed Water Heaters, Pressure Vessels, Pipe**

New Equipment

(For additional information or literature check item numbers on mailing coupon, page 185.)

tural strength. The composition is rot-proof, vermin-proof and is insoluble in water. It may be sawed, nailed or bored with standard tools.

Research Kit

81 Brooks Rotameter Company has developed a compact, portable kit having three integral metering tubes with two special floats for each tube made of pyrex and tantalum. The flow range of this meter is 0.1 cc/min. to 0.5 gpm. of liquid and 5 cc/min. to 2 cfm. of air. The unit can be equipped with brass or type 316 stainless steel built-in needle control valves. It is stocked in end fittings of steel, brass, aluminum, 303 and 316 stainless steel, hard rubber, nickel, monel, durimet, and hastelloy "C." Total weight, including self-supporting legs and carrying handle, is 15 pounds. Folder T-5.

Nickel Alloys Properties

82 Two newly revised technical bulletins on the properties of high alloys have been issued by The International Nickel Company, Inc. Both contain charts, tables on compositions and properties, and working instructions. Bulletin T-7, "Engineering Properties of Inconel," describes Inconel "X," one of the newer age-hardenable Inco nickel alloys. Bulletin T-9 deals with engineering properties of "K" Monel and "KR" Monel.

Hydraulic Cylinders

83 Bulletin No. 500 of Ledeen Manufacturing Company describes a medium duty line of cylinders as to dimensions, weights, ratings and limitations. (See pages 220-21 April PR.) Included are data on the heavy and super duty lines. Selection data is given with illustrations and designs of rod and head attachments.

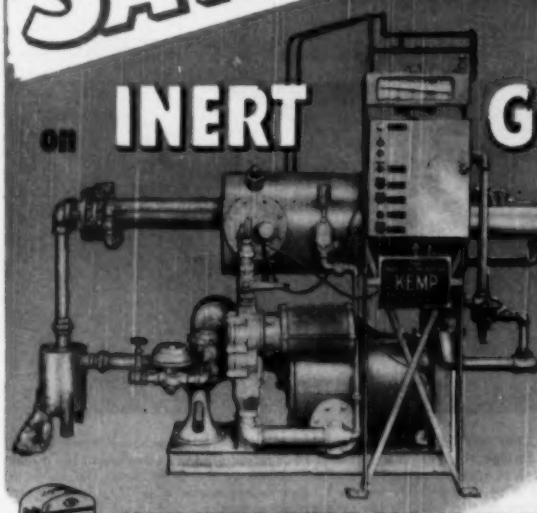
Business Policy

84 Policies of Arthur D. Little, Inc.'s business activities are explained in "Facts for Business Policy." Phases include distribution, revitalizing product lines, potential markets, marketing effectiveness, product acceptance, appraising trends, characterizing an industry and a company, selecting plant sites, project soundness, and regional development.

Hot Water Softeners

85 Boiler plant troubles caused by various impurities in water, and 12 methods of treating water to eleminate these impurities are given in Bulletin WC-102, Graver Water Conditioning Company. More than 30 diagrams of hot process designs and flow charts plus photographs of installations of various sizes and types of units are included.

SAVE! MONEY IN YOUR REFINERY on INERT GAS



NEW KEMP INERT GAS GENERATORS IDEAL FOR PLANTS REQUIRING SMALL VOLUME OF CONSTANT-ANALYSIS INERTS

IF YOU need a compact source of inerts—save money, specify Kemp! Two new Kemp Inert Gas Generators (models MIHE-1 and 2) deliver 1000 and 2000 cfm respectively. Both offer all features of larger equipment: air filter, push-button starting, automatic fire check, flow meter etc. . . . and assure that you get *same analysis* gas from 1% to 100% of capacity.

FOOLPROOF OPERATION

Kemp Generators burn ordinary gas just as it comes from the mains. A famous Kemp Carburetor, part of each installation, assures *complete combustion* without "tinkering" . . . to produce a clean, chemically inert gas containing 88% nitrogen, 12% CO^2 . . . a gas so pure it is used *without further processing* in the manufacture of *aspirin* and *laboratory chemicals*, fine paints and a host of other products.

WRITE FOR DATA

Whether you need inerts for purging, fire protection, mixing, blanketing or a special application . . . specify Kemp. For technical information, write for Bulletin 1-11. *To find out how you can benefit:* tell us how you produce inerts now; we'll show you how Kemp can solve your problem. *Mail Coupon today!*

KEMP OF BALTIMORE

INERT GAS GENERATORS

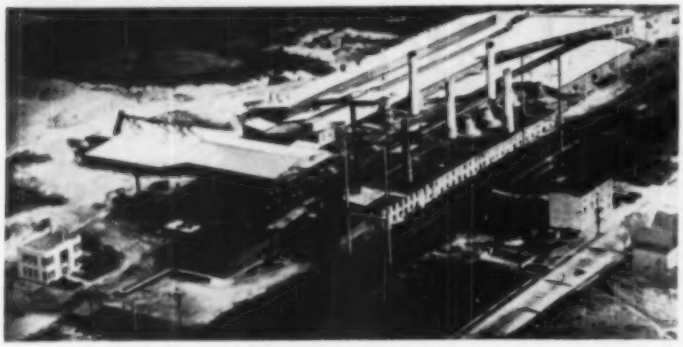
CARBURETORS
BURNERS
FIRE CHECKS
ATMOSPHERE & INERT GAS GENERATORS
ADSORPTIVE DRYERS
METAL MELTING UNITS
SINGEING EQUIPMENT
SPECIAL EQUIPMENT

THE C. M. KEMP MFG. CO., Dept. K-7,
405 E. Oliver St., Baltimore 2, Md.

Gentlemen: Send me information. Also, show me how much we can save on inerts. We now spend ..... per mcf for inerts used in ..... (process.)

Name .....
Company .....
Address .....
City ..... Zone ..... State .....

About EQUIPMENT and SERVICE Suppliers



ACQUIRES BRICK COMPANY—A. P. Green Fire Brick Company has purchased Valentine Fire Brick Company, Woodbridge, N. J., whose line of semi-silica refractories will complement the present line of fire-clay and high alumina refractories manufactured by the Green firm. The Valentine company, located 20 miles southwest of New York operates two tunnel kilns. It is reported that substantial clay reserves were included in the purchase agreement.

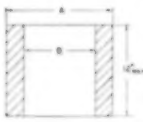
No change is contemplated in the production schedule or the operating personnel of the newly acquired plant. While the operating control of the Valentine plant will remain at Woodbridge, it will be under the over-all supervision of the general offices in Mexico, Mo.

LENAPE
FORGED AND PIERCED RINGS
Save Hours of Machining Time

Designers and fabricators are taking advantage of the inherent economy of Lenape pierced rings of the type illustrated — the OD and ID are press formed to rough dimensions in one operation, thus saving metal and hours of machine time compared to producing from bar stock.

Use Lenape heavy rings at less overall cost!

Lenape forged and pierced rings in carbon, alloy and stainless steels are produced in a wide range of sizes from 6" OD x 3½" ID to 17" OD x 14" ID rough machined or finished to specification.



Rings of this type are frequently used as auxiliary tank fittings, heavy machinery parts, as rollers, bearing sleeves, and stuffing boxes.

Lenape forged and pierced rings are covered in detail on page 46 of Lenape Catalog 9-49. A copy will be sent upon request. Your specific inquiry will be given our immediate attention.

LENAPE HYDRAULIC PRESSING AND FORGING CO.

LENAPE HYDRAULIC PRESSING & FORGING CO.
DEPT. 106 WEST CHESTER, PA.

RED MAN PRODUCTS

Jerguson Gages and Valves Now Made by English Firm

Jerguson gages and valves are now being merchandised and serviced on a world-wide basis as a result of expansion steps recently taken by the Jerguson Gage & Valve Company of Somerville, Mass., in forming an English company in collaboration with Tress Engineering Company. The English company, Jerguson Tress Gage & Valve Company, Ltd., has headquarters at Africa House, London, and uses the manufacturing facilities of Tress Engineering Company, near Newcastle on Tyne, manufacturers of globe valves and gate valves for the petrochemical industry. All parts for Jerguson gages, valves, and engineering specialties are precision made, with parts at both the English and American factories being interchangeable.

Officers and directors of Jerguson Tress Gage & Valve Company are Cecil W. B. Tress, chairman, E. Sheard, chief engineer, and W. Birks Creasser, sales manager, with offices at London. Brooks Stevens Jr., E. E. van Ham, N. Garfield, and James A. Ford, will headquarter at Somerville.

Joins Air Preheater's New York Sales Organization

William H. Larkin, formerly with the Sturtevant Division of Westinghouse Electric Corporation, has joined Air Preheater Corporation's sales organization in New York.

Larkin

Larkin received a B. S. degree in mechanical engineering and business administration from Harvard University in 1925, and a master's degree in business administration from Harvard in 1933. He is immediate past president of the Harvard Engineering Society, and a past president of the New York State Society of Professional Engineers.

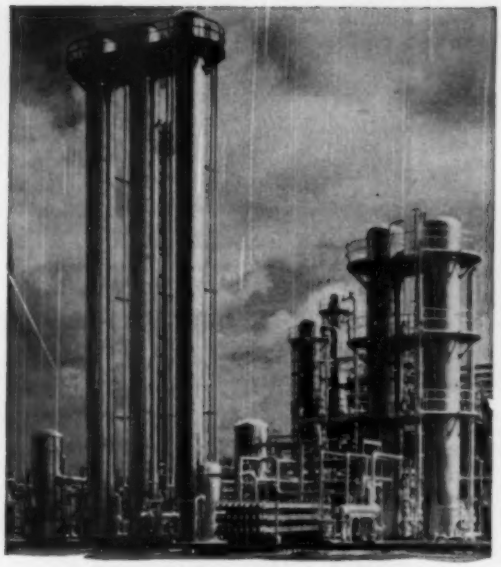
Yarnall-Waring Changes In Sales Organization

Lytton C. Musselman has been put in charge of the Los Angeles district of Yarnall-Waring Company with headquarters in Huntington Park. Other changes in the sales organization include Wallace J. Agren, sales engineer in the Chicago branch, replacing F. C. Harry Vaughan, deceased; R. W. Westlake, sales engineer in the Cleveland branch; Andrew M. Ritter, district manager of Detroit, replacing Charles H. Grosjean who is returning to the New York territory; and Lyle G. Chase Jr., new member of the sales engineering staff, New York.

Power Engineering Company was also named general sales representative in Salt Lake City.

De Laval Canadian Agent

De Laval Steam Turbine Company of Trenton, N. J. announces the appointment of Wilkinson & McClean, Ltd., of Calgary, Alberta, Can. as sales representative for that province. Wilkinson & McClean will handle De Laval tur-



Southwest Gas Producing Co.—Uses

FLORITE

The recently completed gasoline plant of Southwest Gas Producing Company at Dubach, La., gathers wet gas from the surrounding area and employs new highly efficient methods for separating its ethane and propane components. Ninety million cubic feet of natural gas is handled daily, yielding a daily output of 230,000 gallons of liquefied hydrocarbons. The Fish Engineering Corporation of Houston designed and constructed this model plant.

In the two towers at the right of our illustration, wet gas is dehydrated with Florite and then passed to the three towers at the left for high-pressure absorption.

Floridin Products, adapted to a wide range of advanced industrial and technical uses, include several specially prepared forms of . . . . . .

FULLERS EARTH

as well as two grades of Florite, which is a . . . .

BAUXITE-BASED ADSORBENT

Your inquiry will be given careful attention.

FLORIDIN COMPANY

Adsorbents . . . Desiccants . . . Diluents

Department E, 220 Liberty St., Warren, Pa.

are your

- **STILLS**
- **DRYERS**
- **EVAPORATORS**
- **CRYSTALLIZERS**
- **PROCESS VESSELS**

OPERATING AT VACUUMS LIMITED BY THE VAPOR PRESSURE OF THE CONDENSATE?

Many stills, dryers, evaporators, crystallizers and other processing vessels are operating at vacua limited by the vapor pressure of the condensate. This means on the average an absolute pressure of about 2.0" Hg. Most owners of such equipment do not realize how practical and economical it is to put a Booster Evactor in the line between the vessel and the condenser and maintain an absolute pressure of 0.5", 0.25" or even lower. The benefits of this higher vacuum in improving quality and capacity are often very substantial.

The steam jet type of vacuum pump has continually gained in favor for high vacuum in industrial process work. The total absence of moving parts is a big advantage and means many years of service, with no maintenance cost. Available in single, two-, three-, four- and five-stage units for vacuum from a few inches up to a small fraction of 1 m.m. Hg. absolute.

Croll-Reynolds have been specializing on this type of equipment for over 30 years, and have made thousands of separate installations. Their engineers have extensive experience in applying it to numerous different processes, and are available for consultation without obligation. Literature is also available on request.

CROLL REYNOLDS

CROLL-REYNOLDS CO., INC.

17 JOHN STREET, NEW YORK 7, N. Y.

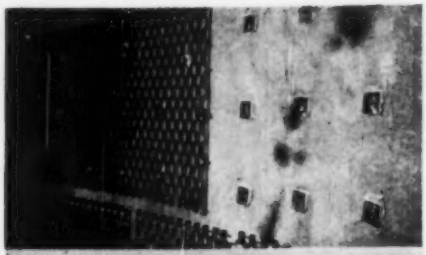
Chill-Vactors **Steam Jet Evactors** **Condensing Equipment**

A. P. GREEN
SK-7
AND
KS-4

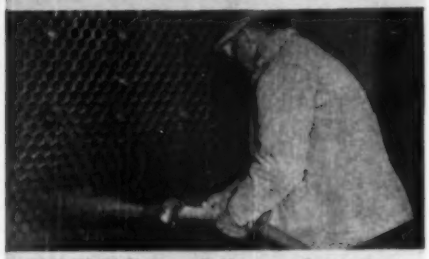
TWO NEW REFRACTORY CASTABLES

DESIGNED AND ENGINEERED FOR "GUN" APPLICATION

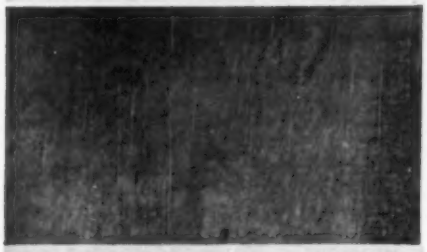
IN THE PETROLEUM FIELD



Application of SK-7 completed. Steel mesh attached to studs preparatory to shooting KAST-SET KS-4.



KAST-SET KS-4 being applied by means of a cement gun. Note steel mesh which anchors KAST-SET KS-4 and provides abrasion-resistant wearing surface for Catalytic Regenerator lining.



Interior of Catalytic Regenerator showing the completed lining with the KAST-SET KS-4 applied over the CASTABLE No. 20 SK-7.

CASTABLE No. 20 SK-7 — a lightweight insulating castable recommended for a service temperature of 1800° F., and KAST-SET KS-4 — a castable refractory with a top service temperature of 2750° F. were designed specifically, for cement gun application in the Petro-Chemical industry. This modern method of applying refractory castables greatly reduces labor costs. The A. P. Green Company, a leader in the development and manufacture of high quality castable refractories for normal pouring application, had the experience and engineering know-how necessary in producing these modern pneumatically applied castables.

Continued research, experimentation and improvement have resulted in the development of these gun-applicable refractory castables which afford the same trouble-free service obtained from A. P. Green mix and pour castables. They have gained wide acceptance in the petroleum industry and are specified by several large companies in that field. The outstanding advantages available through the use of SK-7 and KS-4 are:

1. Installation time and labor costs are reduced considerably, because these materials can be applied quickly.
2. Construction costs are held to a minimum as no forms are necessary.
3. These castables are adaptable to a variety of installations, particularly in places where normal pouring castables cannot be used.
4. The objectionable feature of many gun-applied materials (high rebound loss) has been corrected by the special compounding of these products.
5. Shooting a lining with SK-7 or KS-4 results in a finished installation having the balanced characteristics of a poured castable.

These materials were designed for use wherever castable refractories are required and in places where the use of normal pouring castables is impractical.

For detailed information concerning these castable refractories, write the Engineering Department of the A. P. Green Fire Brick Company — or call your local A. P. Green Distributor.

A. P. Green REFRACTORY PRODUCTS

A. P. GREEN FIRE BRICK COMPANY

Mexico, Missouri, U. S. A.

A. P. GREEN FIRE BRICK CO., Ltd. in Canada

Representatives in the Principal Cities of the World

bines, compressors, centrifugal pumps, speed reducers, couplings and IMO screw-type rotary pumps. Specialized engineering projects and marine equipment will continue to be handled by the De Laval organization in Trenton.

The new agent, which started in business in 1931, is a chartered organization in Alberta.

Becomes Chief Engineer United Centrifugal Pumps

V. Lobanoff has been appointed chief engineer for United Centrifugal Pumps, division of United Iron Works. During recent years, Lobanoff has been credited with major responsibility for development of a number of new United centrifugal pump designs, and a program to affect maximum interchangeability of parts in each line. In his new post, he will continue to direct new design development.

Lobanoff

Lobanoff is well known for his background of experience in designing specialized pumps for refinery and pipe line services, and high-pressure boiler feed applications. He is a member of the American Society of Mechanical Engineers, and the Pacific Coast Electrical Association.

Brown Instrumentation Courses to Begin August 14

Brown Instruments division of Minneapolis-Honeywell Regulator Company will open its second half of 1950 maintenance and repair courses on August 14. The first course, beginning then, will run to September 1 and will include training in pyrometry, ElectroniK potentiometers and pneumatic automatic control. The five-week classes, starting September 11 and October 30, will include the same subjects, also pneumatic transmission, flow meters, thermometers, pressure gauges, and hygrometers. All classes will be conducted at the company school in Philadelphia. The courses are fitted to the requirements of customers sending employes.

A comprehensive 13-week course, to be held from September 11 to December 8, will take up studies of millivoltmeter-type pyrometers, continuous balance (ElectroniK) potentiometers, electrically-operated automatic control, flow meters, thermometers, pressure gauges, hygrometers, air-operated automatic control, Moist-o-Graphs, tachometers, resistance thermometers, gas analysis, and pH and conductivity instruments.

Heads Fibrous Products Sales Of Union Asbestos & Rubber

Frank L. Myers has been appointed general sales manager of the fibrous products division of Union Asbestos & Rubber Company, Chicago, with headquarters of the division at Cicero, Ill. Prior to joining Union Asbestos in 1948, he was with Owens-Corning Fiberglas Corporation in heating, ventilating and air-conditioning.

Myers will supervise the sale of pipe

Because it's BLAW-KNOX
"TWISTED BAR"
Electroforged
Steel Grating

Blaw-Knox Electroforged Stair Treads available with rolled diamond checker plate nosing, twisted crossbar nosing or abrasive nosing.

THE twist does the trick—twisted bar construction gives greater traction, makes slipping impossible even if the grating is wet, greasy or icy. The slightly roughened surface grips shoe soles for *extra* safety, yet the over-all surface is level. Trucks and other wheeled vehicles roll freely. In addition, Blaw-Knox Steel Grating is electroforged into one piece for extra strength and durability.

OTHER ADVANTAGES: Maximum open area for light and air. Self-cleaning, easy to maintain, economical to install.

GET THE FACTS FROM BULLETIN 2296

Big new bulletin gives complete details, specifications, possible applications and all the outstanding advantages of Electroforged Steel Grating and Stair Treads. Write for your copy today!

BLAW-KNOX DIVISION of Blaw-Knox Company
2005 Farmers Bank Bldg., Pittsburgh 22, Pa.

BLAW-KNOX ELECTROFORGED STEEL GRATING

Anyway you figure it....

You get TWICE the VALUE with...

Clark DUO-STEP Leverage STEAM TRAPS

The amazing new Clark Duo-Step design actually *doubles* the drainage capacity of Clark Steam Traps. This means *double value* anyway you figure it. Now you can use smaller, less expensive traps for larger drainage jobs or get *twice* the drainage from traps you have been using.

Sound good? It is! Better look into Clark Duo-Step *today* and start saving real money on your steam trap requirements.

DUO-STEP Leverage

GET THE WHOLE AMAZING STORY... SEND FOR THE DUO-STEP FOLDER TODAY!

THE CLARK MANUFACTURING COMPANY
1847 East 38th St., Cleveland 14, Ohio

LEKTROMESH

THE UNIQUE SOLID-METAL SCREEN

Distinguished for its

STABILITY in Use
UNIFORMITY of Hole Size
WORKABILITY in Manufacturing Processes
DIVERSITY of Applications to Research and Production

Electro-deposited in pure copper, pure nickel, or nickel-on-copper — in regular commercial production with counts from 25 to 400 per inch—in lengths up to 100 feet and widths up to 36 inches—with tolerances on hole size and thickness suitable for the most critical uses—LEKTROMESH is ideal for precise filtration, and for fabricated products such as fuel filters and electronicshields. For full details let us send our Bulletin on LEKTROMESH. Address Department 16.

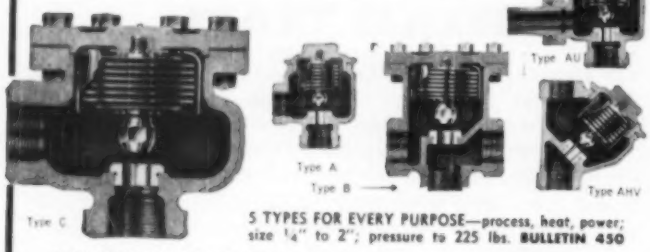
THE C. O. JELLIFF MANUFACTURING CORPORATION SOUTHPORT, CONN.

Well-Known Processor

Puts 37% More Thru Cookers

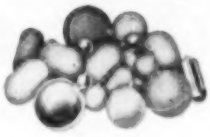
With Nicholson Steam Traps

A leading drug manufacturer found that a recent Nicholson thermostatic steam trap installation, replacing a mechanical type, so cut kettle time that their production was increased 37%. Reasons for Nicholson's faster heat transfer: operate on lowest temperature differential; 2 to 6 times average drainage capacity; maximum air-venting capacity.



5 TYPES FOR EVERY PURPOSE—process, heat, power; size ¼" to 2"; pressure to 225 lbs. BULLETIN 450

HIGH-PRESSURE FLOATS—Stainless, monel, steel or plated steel. Welded. In all sizes and shapes; for operating mechanisms and as tanks or vessels. 2-day delivery. BULLETIN 348.



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207 Oregon St., Wilkes-Barre, Pa.

insulation, metal mesh blankets, tailored insulations, packings, gaskets, textiles, sound-absorbing blankets and specialized building materials evolving out of basic fibers in Union Asbestos plants in Cicero and Earlville, Ill.; Paterson, N. J.; McGregor, Texas, and Marshville, N. C.

Rockwell and Nordstrom Name Agent and Engineer

Rockwell Manufacturing Company has appointed Harry J. Schneider sales representative assisting D. L. Jerman in sales work for all gas products used in the gas industry in the state of New Jersey. Also handled will be the regulator and valve lines of the Pittsburgh

Kentler, Jr.

Schneider

equitable meter and Nordstrom valve divisions of Rockwell.

Schneider attended the Stevens Institute of Technology and was previously employed in the gas engineering department of Stone and Webster Service Corporation.

Charles J. Kentler Jr., with headquarters in Pittsburgh, will cover the chemical, petrochemical and allied industries as applications engineer of the Nordstrom Valve Division.

Kentler received his bachelor of chemical engineering degree in 1940 from Yale University and his Ph.D. in chemical engineering from Cornell University in 1948.

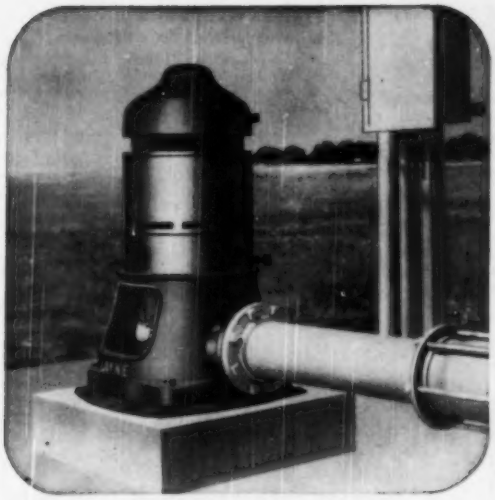
Centrifix Firm Purchases New Cleveland Factory

A 3-story factory containing 27,000 square feet has been purchased by The Centrifix Corporation at 3608 Payne Avenue, Cleveland, Ohio, for light manufacturing and assembly of the company's complete line of internal and line vapor separating and purifying equipment. Also housed will be modern general offices, expanded sales and engineering departments, and enlarged lab and research facilities.

The firm specializes in high-efficiency internal and line purifying equipment based on centrifuge principles. The current expansion is not to affect present manufacturing arrangements in Canada, France, and England.

Heads Penn Sales Engineering

Penn Industrial Instrument Corporation of Philadelphia, manufacturers of Hays-Penn flow meters and Penn temperature and pressure recorders and controllers, has named George D. Keller as manager, sales-engineering department. Keller's experience includes three years in similar work with another instrument manufacturer, four years of engineering and production work with the War Department, Philadelphia Ordnance district, and four years in the sales and engineering departments of



FOR LASTING QUALITY HERE IS AMERICA'S

Top Value

If your requirements call for a Well Water System of utmost dependability, and one that must serve for a long period of years with little or no upkeep expense, you are urged to check the features of those built by Layne. The experience of nearly seventy-five years has gone into their design and construction. With thousands of installations scattered throughout the world, Layne has had an unmatched opportunity to find, correct and greatly strengthen every possible weak point of construction. Constant improvement of design has made them the world's most efficient.

You can also be sure of lasting quality! Extensive research for, and the use of the most suitable metals for all parts has given these famous well water systems an extraordinarily long life under all conditions. Feature for feature, Layne Well Water Systems are acknowledged to be the world's finest. No experienced engineer will question that statement.

Layne will gladly, without obligation, give helpful information on any water supply problem. For further information, literature, etc., address

LAYNE & BOWLER, INC.
GENERAL OFFICES, MEMPHIS 8, TENN.

LAYNE
WELL WATER SYSTEMS
VERTICAL TURBINE PUMPS

ASSOCIATED COMPANIES: Layne-Arkansas Co., Stuttgart, Ark. • Layne-Atlantic Co., Norfolk, Va. • Layne-Central Co., Memphis, Tenn. • Layne-Northern Co., Mishawaka, Ind. • Layne-Louisiana Co., Lake Charles, La. • Louisiana Well Co., Monroe, La. • Layne-New York Co., New York City • Layne-Northwest Co., Milwaukee, Wis. • Layne-Ohio Co., Columbus, Ohio • Layne-Pacific, Inc., Seattle, Washington • The Layne-Texas Co., Ltd., Houston, Texas • Layne-Western Co., Kansas City, Mo. • Layne-Minnesota Co., Minneapolis, Minn. • International Water Corporation, Pittsburgh, Pa. • International Water Supply, Ltd., London, Ont. • Layne-Hispano Americana, S. A., Mexico, D.F. • General Filter Company, Ames, Iowa.

Recalibrate

ON THE JOB WITH THE NEW ROCHESTER DIAL THERMOMETERS!

Accidents are bound to happen . . . like dropping or banging a thermometer sufficiently hard to make readings inaccurate. This could result in costly production errors. To eliminate this possibility, Rochester now offers a new Dial Thermometer with screw adjustment permitting recalibration on the job! All you do is put the instrument in boiling water or other known temperature and reset indicator.

Rochester Thermometers are designed specially for industrial applications. The new precision bi-metallic element is sensitive and quick to respond. Made with a single helix, calibration is not affected by extremes in temperature.

Rochester manufactures a complete line of Dial Thermometers in a variety of dial sizes, stem lengths and temperature ranges. Those shown below are typical. They are available with or without recalibration feature. The cost is surprisingly low. Mail the form below for specifications and prices on your requirements.

FOR HIGH PRESSURES

Rochester solid stainless steel stem design gives you unfailing accuracy plus durability. Available in a wide range of designs.

No. 1725—3" dial No. 1750—2" dial No. 1825—6" dial
Stem lengths 2¼", 3½", 6", 9", 12", 15", 18", 24"
One piece sockets—to fit all stem lengths

TEMPERATURE RANGES		
Fahrenheit	Centigrade	Dual Scale
—50 to 120°F. 50 to 350°F.	—70 to 160°C.	—90 to 130°F.
—70 to 150°F. 0 to 500°F.	—10 to 110°C.	—70 to 56°C.
0 to 200°F. 150 to 750°F.	0 to 150°C.	
0 to 300°F. *200 to 1000°F.	0 to 300°C.	
30 to 240°F.	100 to 400°C.	

*Not recommended for continuous operation above 800°F.

Rochester
GUARANTEED ACCURACY

ROCHESTER MANUFACTURING CO., INC.
38 Rockwood St., Rochester 10, N. Y.

We require..... dial thermometers with temperature range of ..... to .....°; ....." dial; ....." stem.
Please quote.

Name ..... Title .....
Company .....
Address .....
City ..... State .....

They keep you out of trouble . . . and Save You Money

You get a lot of plus values . . . and avoid a lot of failure headaches and possible accidents . . . by using Jerguson Flat Glass Gages for every liquid level indicating use.

Jerguson Reflex Gage

You get the kind of gages and valves you want to do YOUR JOB. Jerguson offers you the most complete line available. Jerguson offers you an engineering organization specializing in building special gages to meet problems.

Jerguson Flat Glass Gages save money and labor. They are easy to install. They stand up . . . you don't have to keep servicing them or replacing the glass. They are available in a wide range of sizes, pressures, designs and materials; also with polished end stems to replace present tubular gages.

Write us about your problems or requirements.

JERGUSON

Gages and Valves for the Observation of Liquids and Levels

JERGUSON GAGE & VALVE COMPANY
100 Fellsway, Somerville 43, Mass.
Representatives in Major Cities
Phone Listed Under JERGUSON

Worthington Pump & Machinery Corporation.

Keller was graduated cum laude from the Harvard Engineering School.

Tube-Turns Distributor Named

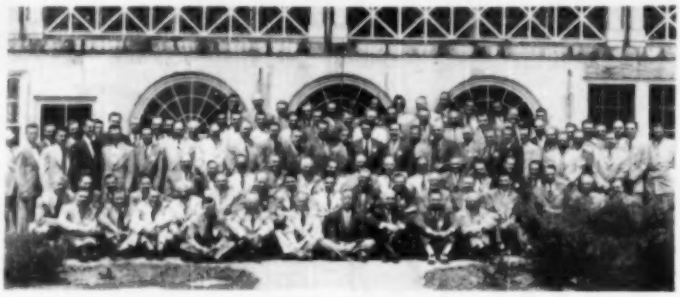
Thomas Robertson & Company, Ltd., of Montreal has been appointed a distributor of Tube-Turns welding fittings and flanges. The company will represent both Tube-Turns, Inc., and Tube-Turns of Canada Limited.

Thomas Robertson & Company, Ltd., is one of Canada's largest suppliers of industrial products, and has branches in Ottawa and the city of Quebec. The company will observe its 100th anniversary in 1952.

Weston's Tagliabue Division Names District Sales Agents

The Tagliabue Instruments Division of Western Electrical Instrument Corporation has appointed district sales representatives handling the Tag line as follows.

C. L. Huffman, Russel F. Clark Company, Pittsburgh; C. W. Stafford, C. B. Fall Company, St. Louis; E. F. Schimbor, Herman E. Held, San Francisco; R. C. Staub, Beedle Equipment Company, Cincinnati; G. O. Miller, Schiefer Electric Company, Inc., Syracuse; T. J. Cunerty, Powerlite Devices, Ltd., Toronto; A. R. Hough Company, Knoxville; Edward S. Sievers, Los Angeles; T. S. Cawthorne Company, Detroit;

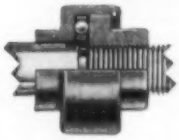


INTERNATIONAL SALES MEETING—Fisher Governor Company recently held a three-day international sales meeting at its home office and factory in Marshalltown, Iowa. One hundred twenty-five representatives, sales engineers and their wives from the Fisher offices throughout the United States, Canada and Mexico were in attendance as guests of the company. The year 1950 marks Fisher Governor's 70th anniversary.

You Get
FASTER–SMOOTHER
Tube Rolling

with IDEAL Tube Expanders

Ball Bearing-Adjustable Thrust Collar



No. 255

No. 270

• Loose collar remains stationary against tube end or sheet, reducing friction to a minimum. Prevents pulling of tube and will not mar sheet—specially ECONOMICAL for production work.

Expanders may be adapted for use with Automatic Torque Controlled Operating Units, for precision tube rolling.

For Complete Details . . . see Your Dealer, or Write Today

The Gustav **Wiedeke** *Company*
DAYTON 1, OHIO

SPECIFY "GENERAL CHEMICAL"

The *Dependable*

Source

for

SULFURIC ACID
ANHYDROUS HF
BORON FLUORIDE†

GENERAL CHEMICAL PRODUCTS FOR THE PETROLEUM INDUSTRY

Alkylation: Anhydrous Hydrofluoric Acid, Sulfuric Acid

Polymerization: Fluosulfonic Acid, Boron Fluoride Etherate

Sulfonation: Sulfuric Acid, Oleum, Sulfan* (Stabilized Sulfuric Anhydride)

Isomerization: Muriatic Acid

Oil Well Acidizing: Muriatic Acid, Fluoboric Acid, Hydrofluoric Acid

Detergents: Sodium Metasilicate, Disodium Phosphate-Anhydrous, Trisodium Phosphate, Tetrasodium Pyrophosphate, Sodium Sulfate-Anhydrous, Sodium Tripolyphosphate, Sodium Silicate Solution

Treating Agents: Aluminum Sulfate, Sodium Sulfate

Mud Conditioning: Sodium Tripolyphosphate, Sodium Silicate, Disodium Phosphate-Anhydrous, Trisodium Phosphate, Tetrasodium Pyrophosphate

Other Chemicals: Aqua Ammonia, Nitric Acid, Potassium Nitrite, Glauber's Salt-Anhydrous

Also Special Catalysts, Addition Agents, Inhibitors

The products advertised are commercial chemicals having various uses, some of which may be covered by patents, and the user must accept full responsibility for compliance therewith. *Reg. U. S. Pat. Off.

†Some Advantages BF₃ Offers in Process Use:

- Operating temperature ranges are wider.
- Yields are increased.
- Separations are easier and no bulky sludges are formed.
- Properties of end-products are improved.
- More reactions are carried to completion.
- Fewer undesirable waste materials result.
- Smaller quantities have greater catalytic activity.
- Little or no extraneous material is introduced into the system.

The ever-increasing requirements of the Petroleum Industry for catalytic and other basic chemicals have been filled successfully by General Chemical since the turn of the century.

For your chemical needs, you will find the coast-to-coast manufacturing facilities of General Chemical extremely versatile . . . convenient . . . and dependable. Whether your production calls for alkylation catalysts, other process chemicals, or custom-made chemicals developed for your particular process, you can rely on General Chemical to "fill the bill."

So many purchasing and operating executives solve their production problems simply by specifying *General Chemical* . . . why don't you?

GENERAL CHEMICAL DIVISION
ALLIED CHEMICAL & DYE CORPORATION
40 Rector Street, New York 6, N. Y.

Offices: Albany • Atlanta • Baltimore • Birmingham • Boston • Bridgeport Buffalo • Charlotte • Chicago • Cleveland • Denver • Detroit • Houston Jacksonville • Los Angeles • Minneapolis • New York • Philadelphia Pittsburgh • Providence • San Francisco • Seattle • St. Louis • Wenatchee and Yakima (Wash.)

In Wisconsin: General Chemical Company, Inc., Milwaukee, Wis.

In Canada: The Nichols Chemical Company, Limited • Montreal • Toronto • Vancouver

ESPECIALLY RECOMMENDED FOR USE IN THE

COPPER SWEETENING PROCESS

Nichols

TRIANGLE BRAND

COPPER SULPHATE

is preferred by leading refineries because of its high copper content, dependable uniformity and exceptional purity and freedom from foreign and inert matter.

99% + PURE

Quotations on request, on any quantity required. Shipments can be made from our nearest plant.

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40 WALL STREET, NEW YORK
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UOP

Inhibitor No. 4

Eicher & Company, Seattle; Ward Engineering Company, Inc., Orlando and Jacksonville; W. J. Keller, New Orleans; and W. H. Dittman, Cowperthwait & Brodhead, Boston.

In the Colorado territory, Peterson Company, Denver, handles sales of chemical and industrial thermometers, hydrometers and moisture meters. Also of Denver, Burson Sales, Inc., handles Celectray pyrometers and the mechanical line of Tag temperature and pressure indicating, recording, and controlling instruments and dial indicating thermometers.

Green Fire Brick Agent Named for Texas Territory

C. J. Yaeger has been appointed district sales manager and sales engineer for the Texas territory of A. P. Green Fire Brick Company, Mexico, Mo. For the past three years, Yaeger has been sales office manager at Mexico. His new headquarters will be Houston.

Yaeger

Yaeger, who received his degree in engineering, has had 12 years' experience in the sale and application of refractory products. Most of his experience has been with engineering problems involved in the installation of refractories in various types of industrial equipment.

Development Engineer Joins Wall Colmonoy Corporation

R. L. Peaslee has joined Wall Colmonoy Corporation as development engineer in charge of the development of Colmonoy brazing alloy as a stainless and alloy steel brazing material. He also will head Colmonoy's alloy brazing department which has facilities for development and production brazing and bright hardening of stainless steel.

Peaslee is a graduate of the University of Cincinnati, department of chemical engineering.

Filtrol Moves Into New National Headquarters

The moving of new national headquarters to 727 W. 7th Street, Los Angeles, has been announced by Filtrol Corporation's president, Wright W. Gary. Facilities have been enlarged to accommodate the growing demand for catalysts, adsorbents, desiccants, and other chemically treated materials, coated seeds, etc., according to Standard R. Funston, manager of sales.

Other offices have been located at 634 S. Spring Street.

Prepo Torch Distributor

Air Reduction Sales Company, a division of Air Reduction Company, Inc., has been appointed national distributor for the welding industry of the recently introduced Prepo Torch, announced by Pressure Products Corporation (June PR, page 192). The torch, which weighs 1½ pounds, gives an instant heat of 2200° F.

Byron Jackson Appoints Pump Project Sales Engineer

Carlos Bartolero has been appointed project sales engineer of the Pump Division, Byron Jackson Company. Bartolero will make his headquarters in Los Angeles, but will spend most of his time in the field. His work will primarily be concerned with problems of pumping in the petroleum processing industries and in the pipe line field.

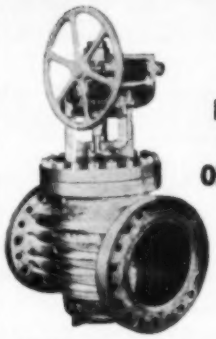
Bartolero

Bartolero was associated with Byron Jackson for eight years, from 1928 to 1936, and has been active in the pump field since that time. He was graduated from the University of California at Berkeley in 1928 with a B.S. degree in mechanical engineering.

A. O. Smith Sales Changes Announced for West Coast

Changes in the west coast sales organization have been announced by A. O. Smith Corporation. Harry M. Evans was named manager of the San Francisco branch. Previous affiliations include replacing J. J. Stahl who was appointed assistant western sales manager of the A. O. Smith motor division at Los Angeles. Evan's previous affiliations include Standard Oil Company, Fluor Corporation, and Southern California Gas Company.

WEDGEPLUG
ALL-PURPOSE
STEEL VALVES



LIFTS TURNS and RE-SEATS IN ONE OPERATION

☆

DRY PLUG

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PRICED to compete with conventional plug-type valves. Interchangeable with American Standard Steel Wedge Gate Valves. Wrench-Operated; Direct Handwheel-Operated; Worm Gear-Operated; Sizes from 1" to 16". Write for our Catalog No. 600 and Price List. On request, we will be glad to quote on larger sizes above 16".

WEDGEPLUG VALVE CO., INC.
Department "R"
NEW ORLEANS 15, U. S. A.

KERLOW
Cylindrical Linings

For Cat Crackers

Cylindrical rectangular armor mats designed to hold cement or lumnite for linings of fluid and cat crackers. In many refineries, these KERLOW ganister linings are permitting considerably higher temperatures and pressures which greatly increase gasoline production from crude.

KERLOW Reinforcing Gratings are made in actions of convenient size which can be readily installed in the field. Write for complete information and prices.

Also Open Steel Grid Trays, Platforms, Walkways, Safety Steps, Drain Grates, and Flooring widely used throughout the Oil and Gas Industry.

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25 Mallory Ave. **Jersey City 5, N. J.**

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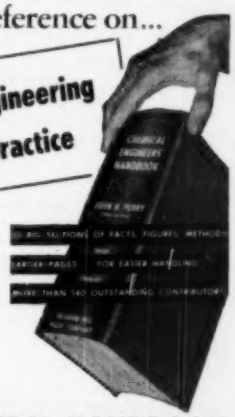

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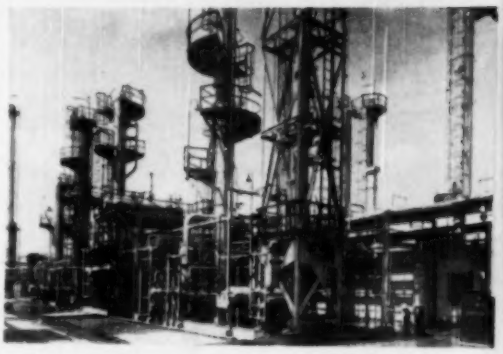

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All replies will be treated with the strictest confidence.

Jim Chase in Kansas City With Marley DriCooler Sales

Jim C. Chase has been named manager of the recently expanded DriCooler sales department of The Marley Company, Inc. He has been located at the general offices in Kansas City, Kan., since joining the company late in 1948. Before coming to The Marley Company, he was the southwest district manager for the Aerofin Corporation working out of Dallas. Chase received his degree in mechanical engineering from Purdue University, Lafayette, Ind.

Chase

Furnace Inclosures Handled By New Laclede Division

Industrial furnace inclosures will be handled by Laclede Arch Company, completely new division of Laclede-Christy Company, St. Louis, Mo. Engineering and sales headquarters will be in the Mallers Building, 5 South Wabash Avenue, Chicago 3.

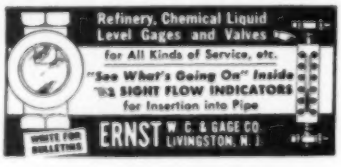
Walter W. Shipley, for many years vice president of Laclede-Christy, will be president of Laclede Arch, with Paul J. Maddox vice president in charge of industrial sales.

R-P&C Valve Sales Manager

Charles L. Haslup, well-known in the valve industry, has been appointed sales manager of the R-P&C Valve Division of American Chain & Cable Company, Inc., with headquarters at Reading, Pa.

Becomes Clapp Sales Manager

A. E. Campbell has been appointed sales manager of Clapp Instrument Company, Webster, Mass.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New Young Radiator Agent For Mid-Continent Oil Fields

J. R. (Bob) Meek of Tulsa, 16 years in the heat transfer industry, is the new Mid-Continent oil fields representative for Young Radiator Company of Racine, Wis., and Mattoon, Ill. Meek has operated extensively in the midcontinent area and was formerly associated with The Happy Company and the T. B. Beaird Company with field headquarters at El Dorado, Ark., Seminole, Okla., and Odessa and Ft. Worth, Texas.

For the past ten years his interest has been with pioneering and promotion of sales of air-cooling equipment to the petroleum industry. Meek's present offices are in the Bob Ward Building, 1341 So. Boston Street, Tulsa.

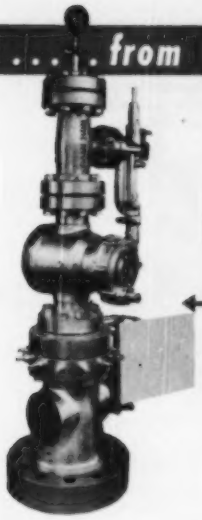
Lunkenheimer N. Y. Manager

Melvin W. Pauly has been appointed New York manager of The Lunkenheimer Company, Cincinnati, Ohio, valve manufacturer. Pauly, associated with the valve industry for over a decade, assumed New York operation June 1.

US Gasket Names Agent

United States Gasket Company, Camden, N. J., has appointed W. S. Shamban & Company, process equipment sales engineers, Los Angeles, as exclusive representative for California. Shamban will offer a complete line of gaskets and packing, including "Chemiseal" Teflon products.

. . . . from Christmas Trees to Catalytic Crackers



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is U·S·S Stainless Steel

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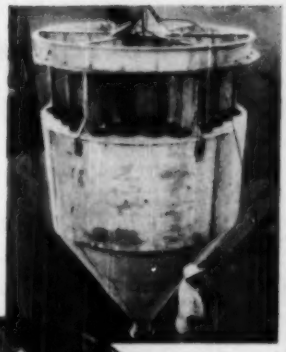
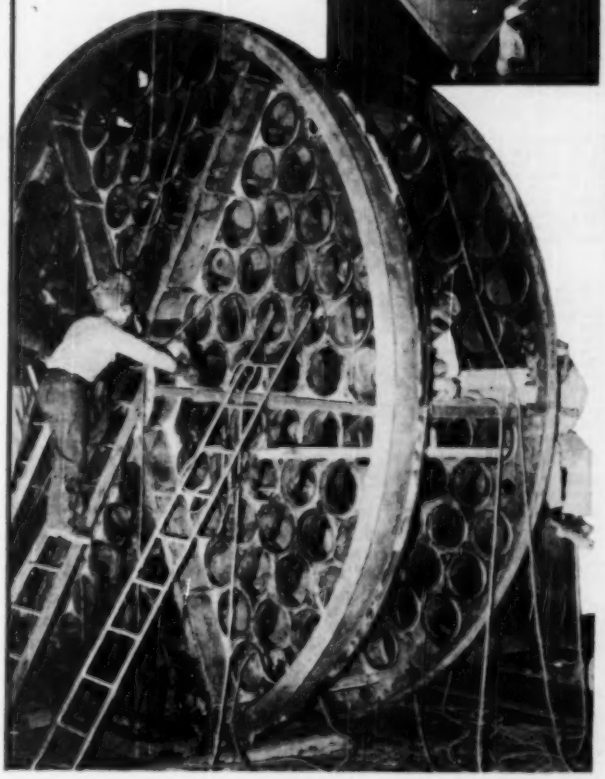
Complete multi-clone assembly for a large cat cracker is made from U·S·S 18-8cb Stainless Steel (Type 347).





FROM the crude oil fields to the finished product, the petroleum industry runs into corrosive materials at every step. And extreme temperatures and pressures complicate the problem. But the industry has a powerful ally in the fight against corrosion—U·S·S Stainless Steel.

In the producing fields, you'll find Stainless in Christmas trees, in shafts and impellers of deep well pumps, in metering floats and springs. In the refinery, Stainless Steel is used in bubble trays and caps, multi-clones, still tubes, transfer lines, vessel linings and hundreds of other applications.

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*** The asterisk preceding name of advertiser indicates that detailed data on products and services of the firm will be found in The 1950 Refinery Catalog.**

A

*Aerofin Corp. 227
*Airetool Manufacturing Co. 171
Alan Wood Steel Co. 173
*Allied Chemical & Dye Corp. 22, 221
*Allis-Chalmers Manufacturing Co. 27
The American Brass Co. 71
American Cyanamid Co. 146, 153
American Iron & Machine Works Co. 169
*American Locomotive Co. 212
American Smelting & Refining Co. 192
American Steel & Wire Co. 225
Armstrong Cork Co. 180
*Armstrong Machine Works 5
*Aurora Pump Co. 192

B

*The Babcock & Wilcox Tube Co. 11
*H. B. Badger & Sons Co. 36-37
*Beckman Instruments, Inc. ..... II Cover
Bethlehem Steel Co. 43
W. H. & L. D. Betz 143
*Black, Sivalls & Bryson, Inc. 35
*Blaw-Knox Co. 176, 201, 217
Bridgeport Brass Co. 163
*Buell Engineering Co. 190

C

Calumet & Hecla Consolidated Copper Co. 6
Carnegie-Illinois Steel Corp. 225
The Chapman Valve Mfg. Co. 170
Chase Brass & Copper Co. 179
*Chemical Construction Corp. 146
Chicago Bridge & Iron Co. ..... I Cover
The Clark Manufacturing Co. 217
Classified Advertising 224
Columbia Steel Co. 200, 225
*The Cooper-Bessemer Corp. 145
*Crane Co. 56
*Croll-Reynolds Co. 215

D

Dallas Tank Co. 34
Davis Engineering Corp. 194
*Dean Brothers Pumps Inc. 198
The Dow Chemical Co. 79
Dresser Industries, Inc. 151
E. I. du Pont de Nemours & Co. ..... 38, Insert 192-193
*The Duriron Co. 202

E

*The Eagle-Picher Co. 50-51
*Elliott Co. 23, 62
*Ernst Water Column & Gage Co. 224
Ethyl Corp. 44-45

F

Federated Metals Division American Smelting & Refining Co. 192
*Fisher Governor Co. 42
Flexitallic Gasket Co. 68
*Flint Steel Corp. 206
*Floridin Co. 215
*The Fluor Corp. 75, 148
*Foster Wheeler Corp. ..... Insert 32-33
The Foxboro Co. 207

G

*General American Transportation Corp. 156
*General Chemical Division Allied Chemical & Dye Corp. 221
*General Electric Co. 48-49
A. J. Gerrard & Co. 224
Goodall Rubber Co. 210
Graver Construction Co. 16
A. P. Green Fire Brick Co. 216
*The Griscom-Russell Co. 66-67
*The Gulf Publishing Co. 223

H

Hagan Corp. 203
*Hamer Oil Tool Co. 158
Hartzell Propeller Fan Co. 19

I

*Industrial Division Minneapolis-Honeywell Regulator Co. 26, 208
*Ingersoll-Rand Co. 47
*International Engineering, Inc. 172
The International Nickel Co. 15, 211

J

The C. O. Jelliff Mfg. Corp. 218
*Jerguson Gage & Valve Co. 220
*The Johnston & Jennings Co. 174

K

*Kennedy & Mattison Co. 187
*The M. W. Kellogg Co. ..... 38, Insert 160-161
*The C. M. Kemp Manufacturing Co. 213
Kerlow Steel Flooring Co. 223
*The Koch Engineering Co. ..... III Cover

L

*Ladish Co. ..... Opp. 16
Landis Machine Co. 7
Layne & Bowler, Inc. 219
*Leeds & Northrup Co. 8
Lenape Hydraulic Pressing & Forging Co. 214
Lukens Steel Co. 199
*The Lummus Co. 2-3

M

Maintenance Engineering Corp. 183
Manning, Maxwell & Moore, Inc. 82
Mason-Neilan Regulator Co. 53
The Master Electric Co. 57
*Metal Goods Corp. 72
*Midwest Piping & Supply Co. 18
*Milton Roy Co. 76
*Minneapolis-Honeywell Regulator Co. 26, 208
*Mixing Equipment Co. 12-13
Mt. Vernon-Woodberry Mills 25
*Murray Iron Works Co. 195

N

*National Aircil Burner Co. 224
*National Carbon Division Union Carbide and Carbon Corp. 184
National Tube Co. 200, 225
Newport News Shipbuilding & Dry Dock Co. ..... Opp. 17
*W. H. Nicholson & Co. 218
*Nordstrom Valve Division Rockwell Manufacturing Co. 28-29

O

*Oakite Products, Inc. 209
*The Ohio Steel Foundry Co. 180
Oil Well Supply Co. 20
*Oliver United Filters, Inc. 178
Orbit Valve Co. 204

P

*Page Steel & Wire Division American Chain & Cable Co. 34
*Penberthy Injector Co. 141
*Perco Division Phillips Petroleum Co. 17
*Petro-Chem Development Co. 55
Petroleum Chemicals Department American Cyanamid Co. 153
*Petroleum Rectifying Co. 168
Petroleum Refiner 197
Phelps Dodge Refining Corp. 222
*Phillips Petroleum Co. 17
*Pittsburgh Corning Corp. 39
Posey Iron Works, Inc. 40
The Wm. Powell Co. 46
*The Pressed Steel Co. 31
*J. F. Pritchard & Co. 155
Proportioneers, Inc. 228

R

*R-S Products Corp. 175
Reading-Pratt & Cady Division American Chain & Cable Co. 9
*Republic Steel Corp. 24, 80-81
*Revere Copper & Brass Incorporated 139
*The Ridge Tool Co. 188
Rochester Manufacturing Co. 219
*Rockwell Manufacturing Co. 28-29
*Rockwood Sprinkler Co. 41
*Roots-Connersville Blower Corp. 151
Rust-Oleum Corp. 161

S

Shand & Jurs Co. 196
Sier-Bath Gear and Pump Co. 182
*Sims Pump Valve Co. 162
Solvay Sales Division Allied Chemical & Dye Corp. 22
The Edward Soph Co. 193
Stancal Asphalt & Bitumuls Co. 205
Standard Oil Company of California 191
*Stone & Webster Engineering Corp. ..... Opp. 64
*Strong, Carlisle & Hammond Co. 167
*Sun Shipbuilding & Dry Dock Co. 32
Superior Manufacturing Co. 193

T

Tennessee Coal, Iron & Railroad Co. 225
*The Terry Steam Turbine Co. 52
The Timken Roller Bearing Co. 4
Turner Halsey Co. 25

U

*Union Carbide and Carbon Co. 184
United States Gasket Co. 205
United States Steel Corp. 20, 200, 225
United States Steel Export Co. 200, 225
United States Steel Supply Co. 225
Universal Oil Products Co. 222

V

*Henry Vogt Machine Co. 166
Vulcan Steel Tank Corp. ..... Opp. 65

W

*Wallace & Tiernan Products, Inc. 21
Walworth Co. 33
Warren Petroleum Corp. 164
Wedgeping Valve Co. 222
Well Equipment Mfg. Corp. 181
*Weston Electrical Instrument Corp. 159
C. H. Wheeler Manufacturing Co. 10
Wheeling Corrugating Co. 177
*The Whitlock Manufacturing Co. 223
*The Gustav Wiedeke Co. 220
A. R. Wilfley & Sons, Inc. 14
Wolverine Tube Division Calumet & Hecla Consolidated Copper Co. 6
Wyatt Metal & Boiler Works ..... IV Cover

Y

*Yarnall-Waring Co. 30

Z

*Zallea Brothers 60

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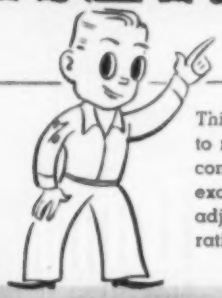

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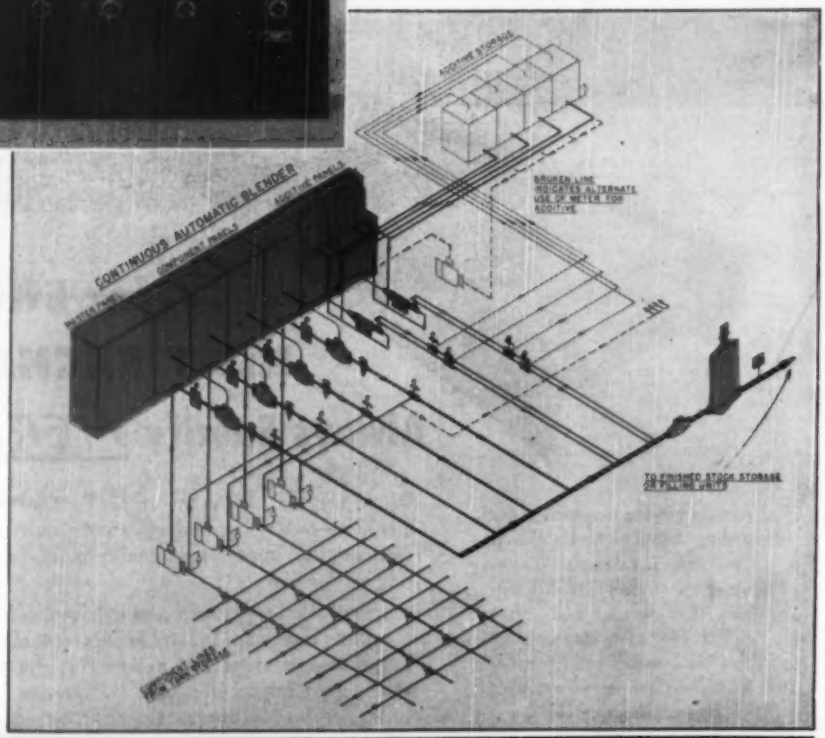
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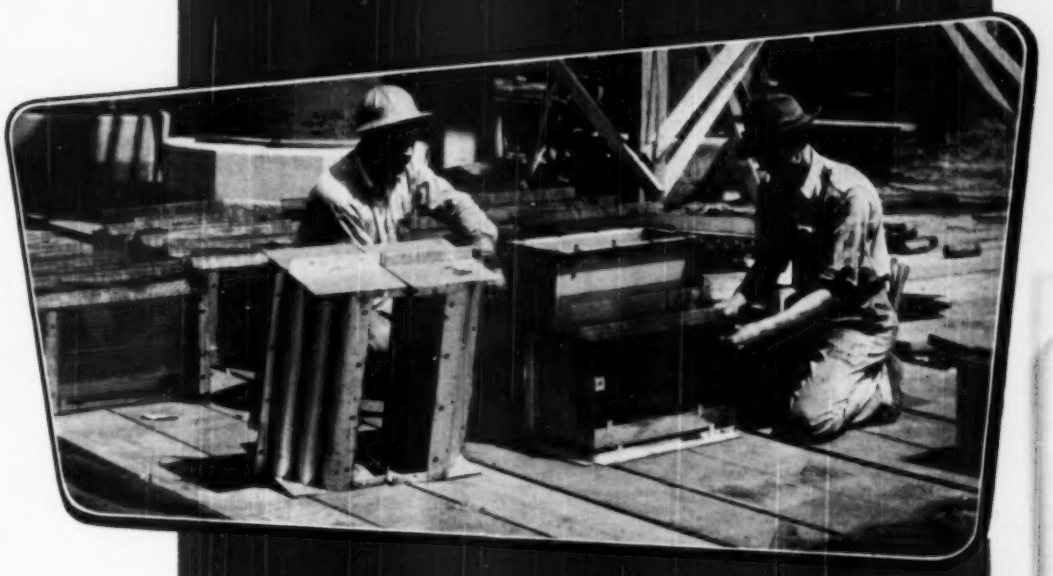

and the Koch Kaskade fractionating trays in our new gasoline plant are operating fine!

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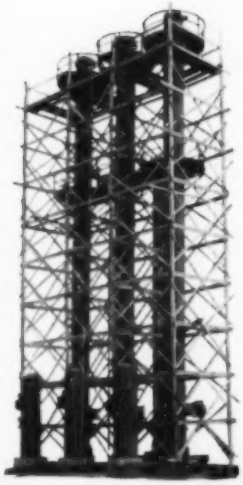

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